SPECIAL PAPER 27

An Economic Analysis of Construction Aggregate Markets and the Results of a Long-Term Forecasting Model for Oregon

By Robert M. Whelan
Mineral Economist
Oregon Department of Geology
and Mineral Industries

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Notice

The Oregon Department of Geology and Mineral Industries is publishing this paper because the information furthers the mission of the Department. To facilitate timely distribution, this report has not been edited to our usual standards.

Summary

This report contains the results of a major applied research project on aggregates. The work was done by the Oregon Department of Geology and Mineral Industries (DOGAMI). The main objective of this research was to produce a long-range forecast of aggregate consumption for every county in Oregon. The project work also yielded new findings that are useful for anyone studying aggregate-related issues in Oregon or elsewhere in North America.

Some of the major findings of this research project are:

- Per capita aggregate consumption varies greatly from place to place. It tends to be much higher in rural areas than in cities.
- Increases in the number of households and personal incomes have a major influence on aggregate consumption. In 1993, growth in households and incomes accounted for about three out of every eight tons of aggregate used in Oregon.
- Over half of Oregon's aggregate consumption goes into projects that accommodate motor vehicles. This includes roads, parking lots, driveways, and bridges.
- Most of the aggregate mines in Oregon are small. Half of the firms that operated mines in 1993 produced fewer than 16,150 tons. The average mine yielded 83,159 tons.
- Urban areas use less aggregate per mile of road than rural areas. One reason for this difference is the higher proportion of residential streets in urban areas.
- High shipping costs isolate markets from outside competition. Communities that block or prohibit new mines can inadvertently create regional monopolies.
- Between 2001 and 2050, Oregon's aggregate consumption will rise 0.53% per year compared to a 1.01% growth rate in the state's population. Consumption will average 55.8 million tons a year. Public works and other government-supported projects will account for 34.3% of this consumption. Almost 30% of total aggregate consumption will go into roads. Other types of infrastructure will use 19%. Nonresidential construction, which also includes farms, will account for 29% of the total. Residential buildings will use 16%.

This report is written in a straightforward and nontechnical style so that readers who are unfamiliar with the aggregate industry can readily use it. The report has three chapters. The first is a general discussion of the factors that influence aggregate consumption. There is background information on how and where aggregate is used. It concludes with an explanation of the forecasting methods we developed.

The second chapter contains the forecast for the entire state. There is also a sensitivity analysis that tells us what the forecast would look like if we assumed different rates of economic growth.

Forecasts for Oregon's 36 counties are shown in the last chapter. Every county forecast comes from a large economic model containing extensive amounts of data. This information has been condensed into two-page summaries for each county.

Much of the data and analytical work presented in this report is based on original research. Information and data gathered from other sources are cited.

The quantities of aggregate in this report are expressed in short tons. Aggregate can also be measured in volume terms. A typical cubic yard of aggregate in Oregon that has been mined, processed, and loaded onto a truck weighs about 1.425 tons. Aggregate in the ground before being mined weighs about two tons a cubic yard. These are averages. Actual densities can be much higher or lower.

Table of Contents

List of Tables

Table of Figures

Chapter One
The Economics of Construction Aggregate Markets

Introduction

In this chapter, we look at some of the general issues regarding aggregates, specific information on Oregon's aggregate markets, and how we created forecasting models for individual counties.

Many of our research findings apply to all parts of the country. In some cases, our conclusions are different from commonly held beliefs. A concerted effort was made to avoid accepting preconceived notions and to test basic assumptions.

The forecasting models we designed are simple and logical. They can be changed to fit counties and towns outside Oregon. Technical information needed to modify the models will be provided in a report to be published at a later date.

This chapter is written in a question-and-answer style. We chose this format because readers can skip parts they are familiar with and find areas specific to their interests. It is also the method we used to begin our research study. We wrote down some very basic questions and then sought the best answers we could find. Many of these questions are commonly asked by the public, county planners, and others concerned about mining and construction in their communities.

What is Aggregate?

There is no strict definition for aggregate. It is generally agreed that aggregate is an inert, high-volume, low-dollar-value material that is usually used to provide bulk to construction projects. Aggregate is the main ingredient in concrete and asphalt pavement. Aggregates are also used as a base on which roads and buildings are placed. Other important end uses include gravel roads, dams, landscaping, drainage control, landfills, mortar, sanding icy roads, and railroad ballast.

The most common types of aggregates are crushed rock, sand, and gravel. In Oregon, we also use volcanic cinders, decomposed granite, pit run rock, and common soil as aggregate. Besides from mining, we get aggregates from recycling materials from industries, building demolition sites, and old road pavement.

Many uses require strict specifications for aggregate. Failure to abide by them can result in poor-quality construction. In extreme cases there can be catastrophic failures. Small differences in quality can result in big differences in the success and durability of a construction project.

In general, good aggregate is made up of rock and mineral particles that are strong, uniform, chemically inert, resistant to weathering, and clean. They can come from natural, synthetic, or recycled sources. The shape of the particles may also be important, depending upon the use.

The quality of aggregates varies greatly in nature. Deposits of rock, sand, and gravel are found throughout Oregon, but many of these are of little or no commercial value. A usable deposit must be large, safe to mine, and near the surface and must contain good-quality aggregate. Aggregate miners must also be able to ship it to customers at competitive costs.

What Are Some of the Other Terms Used in This Report?

Virgin aggregate is any aggregate mined from the earth or dredged from waterways. It does not include recycled materials or aggregate removed from construction-site excavations. We use the phrase "virgin aggregate" here, even though it is not normally used by the aggregate industry. The term is commonplace in other types of mining where recycling has been a major force. Extensive recycling is a fairly recent phenomenon in the aggregate industry.

Crushed rock is common rock mined from quarries or small pits. The rock is then crushed in special equipment that is either fixed on site or portable. Portable crushers are good in locations that operate for only short periods of time. Once crushed, the rock is usually sorted by size and stored for later use. Some sand and gravel pits produce crushed rock by breaking up large pieces of gravel into more marketable sizes.

Oversized rock are boulders that usually come from quarries. They are used for landscaping, repairing erosion damage on streams, building jetties, and other miscellaneous purposes.

Round rock comes in the same dimensions as crushed rock, but the pieces are naturally rounded. They get that way because they were deposited by streams, rivers, or glaciers. The weathering action of water rounds off the rock particles. Small stones at the bottom of a running stream are a type of round rock. Round rock is recovered from sand and gravel mines.

Sand and gravel are familiar construction materials, but many people are unaware how much variation there is in these products. The best deposits are free of clay, dirt, and minerals that will chemically interfere with cement. Even better is sand and gravel with rounded particle shapes. This characteristic is desirable for concrete and mortar. Rounded aggregate allows concrete to flow better and makes it much easier to work with.

About 85% of the sand and gravel mined in Oregon is extracted from the ground. The rest comes from waterways and sand bars.

Some sand and gravel is manufactured. It is produced by crushing rock so finely that it meets the size standards for sand or gravel. Materials made this way have an angular shape. That is a disadvantage if it is used to make concrete.

Fill is used mostly on construction projects to bring the level of land up to a desirable height. This could be for a building site, highway embankment, or other project. Fill is typically a low-value product made of aggregate that has not gone through any processing or cleaning. It can be a mixture of sand, rock, gravel, soil, and clay. For some construction projects, engineers will specify more costly processed aggregates and use them for fill.

Most fill is mined as a byproduct of sand and gravel pits and rock quarries. A few mines in Oregon specifically produce fill as their main product. Construction debris or other recycled products can be used as fill as long as they are safe, inexpensive, and allowed by building inspectors.

Construction sites also produce fill from their excavations for buildings and roads. If it is used on site, it is called native fill. For our purposes, we do not count native fill as part of total aggregate consumption.

Pit run is a term for unprocessed virgin aggregate. Pit run sand and gravel is widely used for construction fill. Pit run rock is rock that has not been washed, gone through a crusher, and been separated by size. It, too, is used as fill. It is also used on logging roads and for other road work.

Shale is a flat, layered rock formed by geologic forces that convert mud into rock. In southwestern Oregon, the term "shale" is also used to describe a variety of volcanic rock that breaks off in layers that look like actual shale. Because it naturally breaks into pieces, Oregon "shale" costs less to mine than regular crushed or pit run rock.

Decomposed granite is another type of aggregate found in southwestern Oregon. It is a variety of highly weathered granite. This rock easily breaks apart and can be readily dug out of the ground. Since decomposed granite is a porous granular medium, it makes an excellent fill for buildings and homes.

Cinder is a lightweight volcanic rock. It is found throughout much of central and eastern Oregon. Cinder was traditionally used to make low-density concrete. That is were the term cinder block originated. Now, it is mainly used on roads and as a landscaping stone.

Cement is a substance made from limestone, clay, and sand that have been heated to very high temperatures and ground to a powder. When cement is mixed with water, a chemical reaction occurs that causes the cement to harden. Cement is used in a variety of products. The most important of these is concrete.

Concrete is a mixture of aggregate, cement, and water. A typical mixture is 11% cement, 16% water, 6% air, 26% sand, and 41% gravel or crushed rock by volume.[1] Concrete is made at a batch plant and then delivered to customers while still moldable. The term for this is "ready mix." When this mixture hardens, it becomes the concrete we are all familiar with. Concrete can also be made at construction sites or used to manufacture precast products at specialized plants.

Making concrete is a complicated process. Proper control requires that high-quality aggregates be used. The aggregate must be free of any minerals or clays that will weaken the concrete or interfere with the hardening process. Different sizes of aggregate are used, ranging from sand to coarse pieces of crushed rock. Rounded aggregate particles are favored, in most cases, because they save labor by making the concrete easier to work with. Nonporous aggregate is also preferred. Concrete made with aggregate that absorbs water and cement is usually weaker and more expensive.

Precast concrete is concrete that is cast into forms at a factory. The finished products are shipped to construction sites. Precast concrete is made in plants throughout Oregon. Examples of products include concrete bricks, paving stones, bridge girders, stairs, septic tanks, planters, catch basins, and sewer pipes.

Concrete masonry is also made in a factory setting. The best-known type of masonry product is the standard concrete block. There are many other varieties of concrete masonry. They are used in building construction and for architectural features.

Prestressed concrete is made by three companies in Oregon. It is a sophisticated cast-concrete product that is reinforced with steel. Prestressed concrete is very strong and is widely used in bridges and other structures, where high-quality, engineered products are critical.

Asphalt is a general term describing a range of oil-based substances that bind particles of aggregate together. Asphalt is made in oil refineries.

Asphalt pavement comes in two basic varieties. They are hot-mix asphalt and cold-mix asphalt.

Hot-mix asphalt is a mixture of about 6% asphalt and 94% crushed rock. These ingredients are normally blended and heated together at hot-mix asphalt plants. The product is then shipped to construction sites. Plants are usually located where aggregate is mined and can be either permanent or portable.

Cold-mix asphalt is also a mixture of asphalt and crushed rock. It is made with a cold asphalt emulsion. The emulsion is a liquid mixture of asphalt, water, and, in some cases, special additives. Cold-mix asphalt is usually made at asphalt plants located near aggregate sources. Cold mix is less expensive than hot mix because it doesn't require heating, drying, and emission control equipment. The process also uses less fuel.

Both types of asphalt work best if made with angular-shaped aggregate. Such rock produces a tougher pavement, because the particles are better able to stay in place and adhere to the asphalt. Hot-mix asphalt works best on roads where there is stop-and-go traffic and that are used by heavy vehicles. While cheaper, cold-mix asphalt tends to be less durable and is used mostly on lightly traveled roads.

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[1] Portland Cement Association, 1995, *Portland Cement, Concrete & PCA: A Brief Guide to the Industry, its Products and Resources.*

Oil mat pavement is similar to cold-mix asphalt. Oil mat uses crushed rock and an oil-based substance, normally cold asphalt emulsions. Instead of being blended before being put down, oil mat is built up in place. One builds oil mat roads by first putting down a layer of coarse crushed rock. This is sprayed with an asphalt emulsion and then compressed. Another layer of rock is put down. This time, a finer grade is used. Again, more asphalt emulsion is sprayed. The process may be repeated a third time with an even finer grade of rock. Oil mat is about a third of the thickness of asphalt pavement.

Oil mat is best used as an alternative to gravel. Oil mat surfaces require less maintenance, provide a smoother ride, and are not as dusty as gravel. Compared to asphalt roads, however, oil mat is far less durable. Oil mat roads are weak and wear out quickly even under moderate traffic. For this reason, they are more common in rural areas.

Base rock is material consisting mostly of large pieces of aggregate. Base rock makes up the lower layer of roads, parking lots, and structures. It has several purposes including that of providing drainage and support.

Improved roads are those with hard pavement or gravel surfaces. In Oregon, 52% of the improved roads are covered with gravel. Asphalt accounts for 35% of the pavement. Oil mat roads are 12% of the total. Just under 1% is paved with concrete.[2]

RAP is an industry term for reclaimed asphalt pavement. It is recovered when old asphalt pavement is torn up or the upper layer of a road is removed during a resurfacing project. This material becomes RAP when it is used for base rock or for new asphalt pavement.

RCA is the acronym for recycled concrete aggregate. When old buildings or sidewalks are torn up, old concrete is removed. If the concrete is free of chemical contamination, such as spilled oil, it can be recycled. The first step is separating the concrete from other construction debris. Then, it is crushed. RCA is a substitute for crushed rock; however, you cannot recover the cement component out of it. Most RCA is used for base rock, but increasingly RCA is finding use as aggregate for making new concrete.

How Much Aggregate is Produced and Used in Oregon?

The Department of Geology and Mineral Industries recently conducted a census of mining in Oregon.[3] It was an critical part of our research. The census established base levels for our forecasts and models. The mining industry believed that past estimates of Oregon's aggregate production were too low.

The census accomplished two goals. By receiving back survey forms from miners representing over 90% of the state's aggregate output[4], we were able to accurately measure production. Secondly, we also totaled the production for every county. Both of these were important goals since there was no other source for this information.

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[2] Oregon Department of Transportation, July, 1994, *1993 Oregon Mileage Report.*

[3] Whelan, R., 1994, *Oregon's Mineral Industries: An Assessment of the Size and Economic Importance of Mineral Extraction in 1993*: Oregon Department of Geology and Mineral Industries Open-file Report O–94–31.

[4] At the time the results were published, returned surveys were 84% of the total. Subsequently, late surveys were sent in equaling about 7% of the total. We did not change the results of our census based on the late survey forms, however, because earlier estimates for nonrespondents proved to be reasonably accurate.

The census showed that, in 1993, Oregon produced 48,740,117 tons of virgin aggregate (Table 1.1). This is 32% to 38% higher than previous estimates. The census, however, is more comprehensive. It includes output from small mines, logging companies, county road departments, Indian reservations, the state's Oregon Department of Transportation (ODOT), and other producers that may have been overlooked in the past. The census also counted in decomposed granite, Oregon "shale," cinders, and some varieties of fill. They are used as aggregate, but are sometimes left out of industry totals.

The production figures on Table 1.1 are broken down into categories of aggregate. The distinctions between these, however, are vague and subjective. The census relied heavily on the terminology chosen by respondents. The same product may be listed under different categories, depending on who filled out the survey form. For instance, sand manufactured at a rock quarry can be classified as crushed rock or sand and gravel. Depending on where it came from, oversized rock could be counted as crushed rock, pit run rock, or in one of the two sand and gravel categories. Therefore, the figures for each category are less precise than the total for all varieties of aggregate.

The census was used to calculate the apparent consumption of aggregate in Oregon. Apparent consumption is the amount of aggregate made available for use in the state during the year. It equals the sum of the production, recycling, and net imports. Actual consumption can differ from apparent consumption, because some aggregate may be added or withdrawn from stockpiles. These stockpile changes are usually minor, and we did not collect data on them.

We estimated, using an informal survey, the amounts of recycled and imported aggregate. Around two million tons of recycled materials were used as aggregate in 1993. Oregon imported, on a net basis, approximately 2,432,900 tons of aggregate from other states. Nearly all of this came from Washington. Oregon exported some aggregate to Idaho. There was another 100,000 tons of net imports in the forms of prestressed, precast, and masonry concrete products.

Adding together all the aggregate sources gives us an apparent consumption for Oregon of 53,273,017 tons. This equals 17.5 tons per person. If we exclude recycled aggregates, per capita consumption totals 16.8 tons. This is slightly more than the 16.0 tons we calculated using similar data for Washington state.[5,6,7]

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[5] The Washington Division of Geology and Earth Resources estimates that 80 million tons of aggregate were produced in 1991 in the state. The population of Washington was 5,012,000 that year.

[6] Lingley, William S., Jr., and Manson, Connie J., September 1992, *Directory of Washington Mining Operations, 1992*: Washington Division of Geology and Earth Resources Information Circular 87.

[7] U.S. Bureau of the Census, *Statistical Abstract of the United States: 1993.*

Table 1.1

1993 Supply and Consumption of Aggregates in Oregon

Source of Supply	*Quantity (Tons)*
Production in Oregon:	
Crushed rock	23,888,974
Pit Run Rock	2,103,315
Decomposed Granite	362,763
Cinders	299,689
Other Fill Material (Pit Run Sand, Gravel, and Soil)	1,255,907
Sand and Gravel from Waterways	3,096,980
Sand and Gravel from Land	17,732,489
Total Virgin Aggregate Production	48,740,117
Recycled Aggregate Consumption	2,000,000
Net Imports of Aggregate	2,432,900
Aggregate Content of Net Concrete Product Imports	100,000
Apparent Consumption	53,273,017

Source: DOGAMI Open-File Report O-94-31.

Who Produces Aggregate?

Aggregate is mined by, or on behalf of, private businesses with mining permits; Indian reservations; government organizations, including federal agencies like the USDA Forest Service (USFS) and the U.S. Bureau of Land Management (BLM); operators whose production is so low that they do not need mining permits; and forest-product companies.

Private businesses with mining permits account for the majority of Oregon's aggregate production. Most of these businesses are owned by individuals who operate on a small scale.

A permit is needed if an owner believes he or she might extract a significant amount of aggregate and sell at least some of it commercially. In Oregon, mines that disturb less than one acre or remove less than 5,000 cubic yards per year do not need permits. If the aggregate comes out of a navigable waterway, a permit from Oregon's Division of State Lands may be required.

In any given year, many permitted mines are either inactive or operate below the minimum level for which a permit is necessary. Permits are maintained for these mines because the operator believes production will increase in the future. Owners of small mines do not have to obtain permits. Many voluntarily register their sites but pay no fee.

Our survey counted 406 private aggregate mine permit holders who produced 40,747,794 tons of aggregate in 1993 (see Table 1.2). Some permit holders operated more than one mine during the year. We estimate that the average operating mine produced 83,159 tons.

Table 1.2

1993 Aggregate Production in Oregon by Source

Type of Producer	*Tons*	*% of Total*
Private Businesses With Mining Permits	40,747,794	83.6%
ODOT	2,011,120	4.1%
Counties and Cities	1,952,687	4.0%
BLM, USFS, & State Forestry Dept.	942,080	1.9%
Private Forestry Not Elsewhere Classified	2,283,843	4.7%
Small Producers with no Permits & Others	802,593	1.7%
Total	48,740,117	100.0%

Sources: DOGAMI Open-File Report O-94-31 and census data analysis.

We ranked the 406 businesses according to their 1993 production volumes. The 29 largest accounted for half of Oregon's total aggregate production. Over 98% of the aggregate extracted by the 406 private producers came from the top 203, or 50%, of the group.

Half of all the active commercial mining businesses with permits in 1993 produced less than 16,150 tons of aggregate. The typical aggregate mine in Oregon is a small seasonal business owned by an individual.

Government mines produced 4,905,887 tons in 1993. Nearly all of it was used for roadwork. Many of the mines were operated by private contractors working in behalf of government agencies. Output from mines owned by ODOT totaled 2,011,120 tons. Counties and cities produced 1,952,687 tons. The BLM, USFS, and the State Forestry Department produced 942,080 tons. This is well below the levels reached in past years. Production from Federal Government sources is down because of cutbacks in budgets and logging activities.

Businesses that mine aggregate exclusively for their own logging roads do not need mine permits unless they sell some of it to others. We estimate that this type of production amounted to 2,283,843 tons in 1993. More aggregate than that was used for logging roads. Some logging companies purchased crushed rock from commercial sources. Also, a few large forest products companies sell rock commercially and are counted among the 406 private businesses with permits.

ıo Uses Aggregate and How Much do They Consume?

While these are basic questions, surprisingly no one collects end-use data for aggregate. The product is so widely used and in so many forms, that it is impractical for us to survey consumers. We can, however, provide some insights into where aggregate is used by analyzing the results of our forecasting models.

The forecasting models we built for this study break down aggregate consumption by end use (see chapter on "How Does the Forecasting Model Work" on page 31). We ran these models and totaled consumption by end uses for the fifty-year forecast period from the years 2001 to 2050. We then calculated the percentage of total consumption that is attributable to each end use. The results are shown on Table 1.3.

According to our forecast, residential construction will take up 16.2% of Oregon's total aggregate consumption. Single-family, site-built homes are the biggest component. The average house uses over 50% more aggregate than one apartment unit or manufactured home.

Manufactured homes are mobile. They are made in factories and then trucked or towed to sites. While trailers are a familiar type of mobile home, their share of the total market has fallen considerably in recent years. Today in Oregon, most new manufactured homes have the appearance of site-built single-family houses. They are trucked to prepared sites, assembled, and secured. In most cases, they remain there permanently.

Nonresidential buildings and related construction will account for 29.0% of the state's aggregate consumption. Most of it will go into new commercial structures such as stores and offices. Parking lots for these buildings use a large share of the aggregate in this type of construction. Maintenance and improvements are another important part of the nonresidential sector. Because of this, additions, remodeling, resurfacing parking lots, and renovations are significant markets for aggregate. There is also more replacement construction, because commercial buildings have shorter lives than residential buildings.[8]

Roads will make up 29.4% of total consumption. The majority of this will be used for improving and maintaining existing roads.

Other infrastructure includes such things as bridges, runways, water systems, sewers, and utilities. Some of these are aggregate-intense end uses. They will account for 19.1% of the state's projected consumption. The remaining 6.3% will go into nonconstruction uses.

We estimate that over half of the projected consumption will be used to accommodate cars and trucks. Besides roads, large quantities are needed for bridges, parking lots, private driveways, garages, service stations, loading docks, trucking terminals, and other related uses.

[8] Kiley, Martin D., *1994 National Building Cost Manual*, Craftsman Book Company. According to the *Building Cost Manual*, an average, class-3 single-family home has a typical physical life of 60 years. Multifamily residences have a life of 55 years. The typical life of offices and stores ranges from 50 to 70 years. For industrial and warehouse buildings, however, it is between 35 and 50 years.

Table 1.3

Forecast of Aggregate Consumption by End Use From 2001 to 2050

End-Use Category	*% of Total*
Logging, Public Forest, & Park Roads	4.7%
Maintenance & Improvements of Public Roads	20.9%
New Public Roads	3.8%
Single-Family Site-Built Homes	7.7%
Single-Family Manufactured Homes	2.1%
Low-Rise Multi-Family Homes	2.5%
High-Rise Multi-Family Homes	0.4%
Other Housing & Multi-Family Conversions	0.1%
Housing: Maintenance, Improvements, & Other	3.4%
Farms, Ranches, & Agricultural	1.6%
Medical Offices & Hospitals	1.4%
Hotels, Motels, & Other Lodging	0.5%
Manufacturing	1.8%
Office Buildings	2.2%
Public Assembly Buildings	1.1%
Retail Stores	3.7%
Schools & Day Care Centers	1.0%
Warehouses	3.1%
Miscellaneous Nonresidential Buildings	1.5%
Nonresidential: Maintenance, Improvements., & Other	10.6%
Bridges	1.4%
Dams & Reservoirs	0.8%
Railroad Track, Ballast, & Crossings	0.4%
River & Marine Facilities	0.6%
Sewer & Water	9.7%
Miscellaneous Nonbuilding Construction	2.2%
Infrastructure: Maintenance, Improvements, & Other	4.8%
Nonconstruction & Other Miscellaneous Uses	6.0%
Total Consumption	100.0%
Less Recycled Aggregate	-6.8%
Virgin Aggregate Consumption	93.2%
Total Consumption by Major Class:	
Residential Construction	16.2%
Nonresidential Construction	29.0%
Roads	29.4%
Other Infrastructure	19.1%
Railroads & Nonconstruction Uses	6.3%

Source: DOGAMI Aggregate Model Forecast 2001 to 2050.

How Does New Housing Affect Aggregate Consumption?

As noted before, housing is a big end use for aggregate. In this report, we use the term "housing unit" to describe any place, other than a group home, where a household lives. Single-family homes and apartments are the most common kinds of housing units. Group homes are places such as dormitories, shelters, nursing homes, and prisons.

Housing's 16.2% contribution to total aggregate consumption is just part of its effect. New housing also creates demand for roads, sewers, water systems, community buildings, parks, fire houses, and related projects. Collectively, these have a major impact on aggregate consumption.

Whenever a new household forms or moves in from another area, the number of occupied housing units goes up by one. New households form when older children or adults from one household move out to live on their own.

A new household's impact on aggregate demand depends on the choice of dwelling. They can move into a vacant unit, turn a vacation home into a year-round residence, create a home out of some other type of building, or go into a newly built unit. Newly built units require far more aggregate than the other choices.

Another factor affecting consumption is the type of unit built. A site-built single-family house requires more aggregate than other types of housing. Apartments, for instance, use less aggregate because each unit shares its foundation and walls with other units. There are also common parking areas, walkways, front steps, underground utilities, and facilities.

How a community accommodates growth has a big influence on its need for aggregate mining. If high-density housing is put into existing urban and suburban neighborhoods, a community will use far less aggregate than if it constructs site-built single-family developments on farm land.

Communities where housing is abandoned in one area and replaced with new units on vacant land elsewhere will use far more aggregate than those that refurbish old housing. Even if a community tears down old housing and rebuilds new units on the same sites, it will use less aggregate. That is because roads, sewers, and other housing-related construction are not needed.

On Table 1.4, we show the pattern of housing additions in Oregon for the period of 1980 to 1993. Single-family site-built homes accounted for 54% of the new units put in place. Single-family manufactured homes were 18% of the total. Multi-family units made up 23% of the new housing units. The remaining 5% were units that used very little, if any, aggregate. These include motorized homes, floating homes, house boats, and some homeless families.

Single-family housing dominates the market in Oregon. The share held by multi-family housing, however, is growing. While more common in urban counties, multi-family units are also popular in some rural counties where household incomes are modest.

In 1980, Oregon had many vacant housing units. This oversupply helped absorb some of the impact of the state's growth in recent years. From 1980 to 1993, 18% of the new households were accommodated by vacancies. Now, in much of the state, vacancies have dwindled to low levels. Further growth will have to rely more on new housing construction than before.

Table 1.4

New Housing Put in Place in Oregon From 1980 to 1993

Type of Unit	Housing Units
New Units Put in Place:	
Single-family Site-built Homes	141,798
Manufactured Housing	48,493
Low-Rise Multi-Family Housing	50,272
Multi-Family Units Arising from Conversions [9]	6,700
High-Rise Multi-Family Housing	3,868
Other Housing (Net Change) [10]	13,109
Total Additions	264,240
Changes in Housing Stock:	
Total Additions	264,240
Plus Reductions in Vacancies	31,490
Minus Increase in Vacation & Seasonal Units	(20,253)
Minus Units Lost [11]	(96,261)
Net Increase in Households	179,216

Sources: U.S. Census of Population; F.W. Dodge, Inc., construction statistics; the Oregon Manufactured Housing Association; the U.S. Census of Housing; and estimates by DOGAMI.

How Much Aggregate is Used on Publicly Funded Projects?

We estimate that 34.3% of the virgin aggregate consumption from 2001 to 2050 will go into government projects (see Table 1.5). Governments use a disproportionate share of Oregon's aggregate because they are responsible for maintaining public roads. Road work is an aggregate-intensive activity.

One benefit of doing so much road work is having access to a large and low-cost supply of RAP. Governments pay for the majority of asphalt resurfacing projects in Oregon. This puts them in the position of being the state's biggest aggregate recyclers. In addition, public agencies, such as ODOT, often sponsor recycling research.

Table 1.5 shows a calculation for aggregate consumption on government-related projects. It is based on estimates for the percentage shares of different types of construction that will be publicly financed from 2001 to 2050. These percentages are educated guesses.

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[9] Most conversions are single-family homes that are made into two-family houses. Some conversions are the result of turning commercial buildings into apartments or condominiums. This number is an estimate made by the Department of Geology and Mineral Industries.

[10] Motorized homes, recreational vehicles, vans, floating homes, and households of homeless that do not live in group homes or shelters.

[11] Losses occur when housing units are torn down or are condemned or converted to other uses such as commercial businesses or other forms of housing.

Table 1.5

Forecast of Aggregate Consumption on Public Projects from 2001 to 2050

End-Use Category	% Publicly Financed	Tons Per Year Use on Public Projects
BLM, USFS, State Forest and Park Roads	100%	930,321
Multi-Family Housing	2%	31,670
Railroad Ballast & Crossings	2%	4,847
Maintenance & Improvement of Public Roads	95%	11,061,781
New Road Construction	15%	317,228
Airport Buildings	65%	71,410
Jails and Detention Centers	100%	51,565
Hospitals and Heath Care Facilities	5%	40,313
Misc. Nonresidential	5%	13,554
Municipal	100%	97,437
High-Rise Offices	15%	41,627
Low-Rise Office Buildings	10%	96,609
Retail	1%	20,751
Public Assembly	5%	31,901
Schools	65%	348,563
Warehouses (Nonrefrigerated)	2%	32,639
Airport Runways	70%	28,398
Bridges & Related	95%	737,159
Dams & Reservoirs	65%	299,822
Miscellaneous Non-Buildings	25%	174,928
River & Marine	40%	144,663
Sewer, Water, & Related	60%	3,259,786
Sidewalk & Parking Not Elsewhere Classified	60%	92,209
Maintenance, Repair, & Other Nonresidential	5%	295,328
Maintenance, Repair, & Other Infrastructure	50%	1,351,242
Other Uses Not Elsewhere Classified	15%	499,063
Total Aggregate for Public Projects		20,074,814
Less Recycled Material	60%	(2,266,594)
Total Virgin Aggregate for Public Projects		17,808,220

Source: Estimates made by DOGAMI from the aggregate model forecast for 2001 to 2050.

Is Per Capita Consumption a Good Way to Forecast Demand?

There is a widely held belief that aggregate consumption is directly proportional to population. That means, if the population doubles, so will aggregate demand. Put another way, the number of tons used per person is constant no matter how the population changes. Our research shows that this is not true. While aggregate consumption is related to population, the relationship is far more complex than a fixed ratio.

In Oregon, for instance, 17.5 tons of aggregate was used for every person living in the state in 1993. If per capita consumption were a good forecasting tool, we should be able to multiply each county's population by 17.5 to get the county's aggregate consumption. When we do this, however, the results are often far off. They range from 66% too high to 86% too low. Only five of Oregon's 36 counties have consumption rates that are within 10% of 17.5 tons per capita.

The tons per capita method does not work. It fails to consider the impacts of growth, how aggregate is used, and the choices citizens make about construction activities. Still, while there is no one-to-one link between population and consumption, the two variables are nonetheless related. After all, the more people there are, the more construction you are likely to have. But population gives only a partial explanation for consumption.

Our research shows that population density is a key variable. The population density equals the number of people living on the average square mile of land. We found that per capita aggregate consumption is lower in places where the population density is high.

The density relationship is clear when we look at national data. Table 1.6 is a list of population densities and per capita aggregate consumption by state. We assumed that each state's aggregate production equaled its consumption. There are flows in and out of states, but these are usually small. The production data come from the U.S. Bureau of Mines.[12] They are not comparable to the production census done by DOGAMI. The Bureau of Mines does not cover recycling and all the producers we surveyed in our study. It also excludes certain categories of aggregates. The Bureau of Mines, however, is the only source of consistent national aggregate data.

[12] U.S. Bureau of Mines, *1990 Minerals Yearbook.*

Table 1.6

U.S. Bureau of Mines Estimates of 1990 Per Capita Consumption Versus Population Densities by State

State	Aggregate Consumption (Tons/Person)	Population Density (People/Sq. Mi.)	State	Aggregate Consumption (Tons/Person)	Population Density (People/Sq. Mi.)
Alabama	12.4	78.2	Montana	11.7	5.3
Alaska	32.4	0.9	Nebraska	9.8	20.4
Arizona	9.1	32.1	Nevada	16.6	10.9
Arkansas	11.7	44.2	New Hampshire	7.7	119.5
California	5.9	187.5	New Jersey	4.5	992.7
Colorado	9.9	31.6	New Mexico	8.4	12.5
Connecticut	5.7	655.0	New York	3.9	366.3
Delaware	3.3	325.8	North Carolina	9.8	125.9
Florida	7.1	220.5	North Dakota	13.5	9.0
Georgia	9.0	110.0	Ohio	8.6	262.4
Hawaii	6.7	171.2	Oklahoma	11.0	45.0
Idaho	13.4	12.1	Oregon [13]	11.9	29.3
Illinois	8.3	202.9	Pennsylvania	9.8	262.2
Indiana	10.9	153.2	Rhode Island	3.6	827.6
Iowa	15.8	49.3	South Carolina	10.0	112.1
Kansas	12.8	30.1	South Dakota	20.8	9.0
Kentucky	16.0	91.2	Tennessee	12.8	115.7
Louisiana	4.0	88.4	Texas	7.5	63.7
Maine	7.8	36.9	Utah	10.6	20.3
Maryland	10.2	457.1	Vermont	13.1	58.6
Massachusetts	3.7	726.2	Virginia	11.7	151.8
Michigan	10.4	158.8	Washington	10.9	71.4
Minnesota	9.8	51.8	West Virginia	8.5	74.0
Mississippi	5.6	54.0	Wisconsin	11.5	87.1
Missouri	12.2	73.4	Wyoming	14.4	4.6

Sources: U.S. Bureau of Mines and U.S. Bureau of the Census.

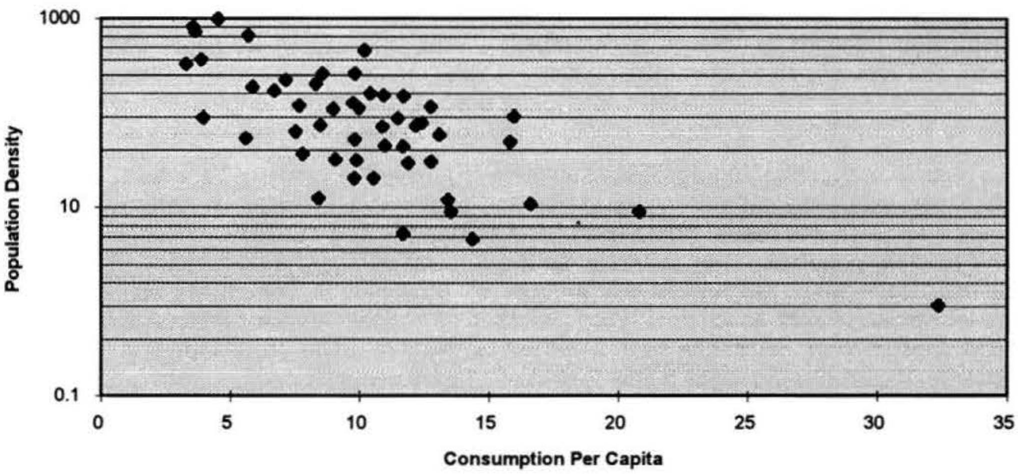
[13] The aggregate consumption figure shown here is lower than what the Department of Geology and Mineral Industries reported for 1993, because the U.S. Bureau of Mines surveys fewer producers and does not include certain types of aggregates in its totals. Also, the U.S. Bureau of Mines figures reflect activity in 1990 and include rough estimates for crushed-stone production.

As can be seen from Table 1.6, states with high population densities reported low levels of per capita consumption. Statistically, there is a very significant relationship between population density and consumption per capita.[14]

We plotted the relationship on Figure 1.1. The states with high population densities use less aggregate per person. The data points for these states are clustered in the top left corner of Figure 1.1. As you move to the right, the consumption per capita rises while the population density falls. The data points follow a downward-sloping pattern. If consumption per capita were a fixed ratio, the data points would appear as a vertical line.

Figure 1.1

Population Density Versus Aggregate Consumption Per Capita by State in 1990



Sources: U.S. Bureau of Mines and U.S. Bureau of the Census.

Three reasons explain most of the differences. They are housing choices, driving distances, and the intensity of use for structures.

A great deal of aggregate is used in residential construction, but the amounts vary with the type of housing. According to our forecast, a site-built house will require 61% more aggregate to build than a unit of an apartment building. Since multi-family housing is more prevalent in urbanized counties, those areas will use less aggregate for every new housing unit they add.

Driving distances are greater in rural areas and they have more road miles per person. In 1993, there were 485 miles of public roads in Harney County for every thousand residents. Harney has the lowest population density in Oregon. In Multnomah, which has the highest density, there were 5.0 miles of public roads for every thousand people. Because of this difference, Harney County uses more aggregate for roads on a per capita basis than Multnomah County.

[14] There is a –0.72 correlation between the natural logarithm of consumption per capita and the natural logarithm of population density. The regression equation derived from the U.S. Bureau of Mines data worked out to ln{tons per capita} = 3.21–0.23*ln {population per square mile}.

The intensity of use for structures is the third key factor. This means that a single structure, such as a store or a water main, is usually shared by more people in urban areas than in rural areas. Since more people share these structures, less aggregate is used per person to build them. For instance, retail stores tend to be busier in cities than in rural towns. This is usually true for other types of public buildings as well. Because of this higher intensity of use, cities have fewer square feet of buildings per person on average. Therefore, their per capita consumption of aggregate for buildings is less.

Overall, the amount of aggregate consumed per person tends to be less in urban areas. This relationship can be masked by sudden growth. New households stimulate one-time demand for aggregate. This effect is short lived. Once the new residents become settled and the initial impact of their arrival is absorbed, per capita aggregate consumption falls.

What Drives Aggregate Consumption?

Construction activity is the principal driver of aggregate consumption. Existing households and businesses replace obsolete structures, make repairs, and put on additions. New households stimulate the construction of new buildings and roads.

Construction depends largely on a community's size, changes in its population, and income growth. The type of construction activity dictates which measure is used in a forecast. A county's road mileage, for instance, is related to its land area. The number of retail stores is tied to total personal income. School construction follows changes in the number of the school-age children.

Our research shows that aggregate consumption is mostly the result of base level demand. This is the aggregate used by existing residents and businesses to maintain, improve, repair, and replace structures and roads. Some base level demand is also caused by changes in the needs of the existing population. For instance, as the population ages, a community may build more hospitals. Base level demand is the amount of aggregate a community will consume if it experiences no growth in its population, number of households, or personal income. As with overall consumption, per capita base level use is lower in urban areas than it is in rural areas. Statewide, it currently averages a little less than 11 tons per person.

Growth is an important contributor to aggregate consumption. Every time new households settle in a community, demand is stimulated for homes, roads, utilities, hospitals, stores, work places, and other structures.

Real personal income growth also generates demand for aggregates. Personal income is the money people get from work, investments, pensions, public assistance, and other sources. Real growth occurs when this amount of money rises at a rate faster than the cost of living. When real personal incomes rise, demands for stores, recreational facilities, and other buildings increase.

What Are the Contributions From Growth and Base Level Use?

We can answer this question by using our forecasting models. We must rely on estimates, however, since we cannot fully divorce the effects of population growth from income growth. Factors such as vacancies, age distributions, population densities, and average household sizes also affect the outcome. We chose 2001 for this analysis because it is the first year of our forecast. Its characteristics come closest to matching the current situation in the state.

Although more people will live in Oregon in 2001 than in 1993, the economy will be growing at a slower rate. Total aggregate consumption is forecast at 48,339,992 tons. This is 9.3% less than the 1993 level. Besides slower growth, a falloff in logging-road work, more substitution of aggregates, and less favorable demographics will also contribute to the decline.

The population in 2001 is forecast to go up by 1.24% from the previous year. In 1993, it rose at the much higher rate of 1.98%. The number of households will rise 1.38% in 2001 compared to 2.04% in 1993. Real personal income will also grow at a slower rate in 2001. Overall, 1993 was an unusually strong year for the economy, and this is reflected in its higher aggregate consumption.

We forecast the base level use for 2001 by assuming that there will be no growth in the population, income, technology, or number of households. These assumptions were put into each county aggregate model. The results were totaled for the whole state and are shown on Table 1.7.

Our forecast shows a base level use of 35,875,313 tons in 2001. That equals 74.2% of total aggregate consumption. We estimate that it was about 33,000,000 tons or 61.9% of total consumption in 1993. The base level is higher in 2001 compared to 1993 because the population is expected to be 11.9% greater. With much slower growth in 2001, however, the contribution to consumption from growth will be nearly eight million tons less.

Table 1.7

Factors Contributing to Total Aggregate Consumption in the Year 2001

Contributing Factor	*Tons*	*% of Total*
Base Level Use	35,875,313	74.2%
Growth in Population & Households	11,108,931	23.0%
Growth in Real Personal Income	1,393,620	2.9%
Technological Changes	(37,873)	(0.1%)
Total Aggregate Consumption	48,339,992	100.0%

Source: Simulations using DOGAMI's aggregate forecasting models.

Our forecast shows 23.0% of the expected aggregate consumption in 2001 coming about because of that year's growth in population and households. It amounts to 11,108,931 tons or 266 tons for every new resident in the state. Once the initial impact of these new residents is over, their consumption of aggregate will fall back to towards the base level.

Income growth has a modest effect on consumption. It contributes 2.9% or 1,393,620 tons to total aggregate consumption in 2001.

The final component to our forecast is technology. This variable accounts for new methods and materials that let construction crews use less aggregate on their projects. It is a minor component to the forecast for 2001, although in later years it does has a large cumulative effect. Savings in aggregate consumption from technological improvements are 37,873 tons or 0.1% of total consumption in the year 2001.

As can be seen from the data on Table 1.7, new households have a large impact on consumption. The question arises: What are these new households using aggregate for? From the results of our models we estimate that the use by new households is divided roughly evenly between residential, infrastructure, and nonresidential building construction. The three biggest end uses are new single-family homes, roads, and sewer and water lines.

Table 1.8 provides some insight into how much construction occurs for every new household. It shows the number of square feet per new household for the period from 1978 to 1993. Some of this was replacement, improvement, and maintenance construction. A large portion, however, was done to accommodate new households.

Table 1.8

Square Feet of Buildings Put In Place Per New Household In Oregon From 1978 to 1993

Building Type	Square Feet Per New Household
Airport	8.7
Jails and Detention Centers	5.3
Medical Offices and Hospitals	54.1
Hotels, Motels, and Lodging	24.7
Manufacturing	78.2
Municipal Buildings	8.7
Office Buildings	114.6
Parking Garages and Service Stations	29.9
Public Assembly	60.1
Retailers	149.4
Schools	53.8
Warehouses	138.1
Miscellaneous Nonresidential Buildings	22.8
Apartment Buildings	245.2
Site-Built Single-family Homes	1,099.6
Manufactured Homes	302.1
Total	2,395.3

Source: F.W. Dodge construction statistics[15] and DOGAMI.

Is the Impact of Growth the Same in All Counties?

Growth has a greater impact on urban counties. The reason why this is so has to do with roads. Road maintenance makes up a much higher proportion of total aggregate consumption in rural counties. This end use, however, is less sensitive to growth than building construction.

Oregon's rural counties have nearly five times as many road miles per household than the ten most urbanized counties. Maintaining and repairing these roads takes up a large share of the aggregate consumed in the rural counties. Much of that is base level consumption. Therefore, if the economies of two counties each rise 5%, the percentage increase in aggregate consumption will be greater in the more urbanized one.

Do Urban Counties Use More Aggregate on Their Roads?

The answer to this question is surprising. We initially suspected that urban counties use more aggregate on their roads because they have greater numbers of wide streets and heavier traffic. We tested this belief by surveying county road departments. The survey revealed that urban counties actually use less aggregate on every mile of road.

We called all 36 county road departments in Oregon to determine how much aggregate they used on county roads in 1993. This included all types of aggregate, including the rock contained in asphalt put down by contractors and cinders used for ice control. By surveying county road departments, we got a good representative sample of regional consumption patterns.

[15] F.W. Dodge Inc., Market Analysis Group, *1994 Oregon Construction Database Assembled for the Department of Geology and Mineral Industries.*

The results of our survey are shown on Table 1.9. In 1993, county road departments used 4,815,964 tons of aggregate or 202 tons for every mile of road. Nearly all of it was used to maintain, repair, widen, and improve existing roads.

New roads in Oregon are usually built by the private sector. Developers of housing projects and commercial buildings put in new roads. These are often turned over to cities or counties who then become responsible for their maintenance. The high costs of acquiring land and constructing new roads severely limits new road construction on the part of the state and local governments.

Although there were exceptions, there was a distinct pattern in the data. The usage rate of rural counties was 41% higher than the usage rate of urban counties. The ten most urbanized counties used 160 tons of aggregate per mile of road. The other 26 counties, which we classify as rural, used 226 tons per mile. This happened even though the number of households in urban counties rose 2.3% compared to a 1.5% rise in rural counties. In areas with strong growth, there is often a need to widen and improve roads. This stimulates higher aggregate consumption.

We made follow-up calls to road departments to find out why there was such a large difference in usage rates between rural and urban counties. They offered several reasons.

Climate is one factor. Rural counties tend to be in places that get harsh winter weather. Over 150,000 tons of aggregate each year in Oregon are used for sanding icy roads. Rural county drivers rely heavily on traction devices. These, together with frequent thawing and freezing cycles, cause road damage. Snow plows add to this problem. For these reasons, roads in these areas require frequent repairs and maintenance.

Many roads in rural Oregon are heavily used by large trucks and recreational vehicles. This type of traffic causes considerable wear and tear. In total, rural areas have less truck traffic than urban areas, but they also have fewer truck routes. Consequently, their commercial traffic is funneled onto fewer roads.

Compared to rural areas, urban and suburban regions have much higher concentrations of small residential streets. This is because they have large populations that live in extensive residential developments. In rural counties, houses tend to be on or near major roads. Residential streets have thin pavements and bases. They are rarely resurfaced, widened, or repaired. Consequently they use relatively little aggregate for maintenance.

Asphalt streets are periodically resurfaced. The amount of aggregate used for this depends on the thickness of the overlay. An overlay is a new surface put on top of old pavement. In urban areas, overlays are thin because road departments do not want the pavement to rise above curbs, driveways, and cross streets. Rural roads usually do not have curbs. They have fewer street crossings and other obstacles in their paths. Rural county road departments, therefore, tend to put down thicker overlays.

Gravel roads can use large amounts of crushed rock. Rural counties have busy gravel roads. This is especially true in eastern Oregon. New gravel has to be put down on actively traveled routes as often as every five years or less. In urbanized counties, gravel roads are often minor routes and receive little attention.

Table 1.9

County-Controlled Roads: Total Road Mileage and Aggregate Consumption in 1993

County	Tons of Aggregate Used	Miles of County Gravel Roads	Miles of County Asphalt, Oil, & Concrete Roads	Tons Used Per Mile of Road
Baker	140,000	498	181	206
Benton	60,140	174	222	152
Clackamas	179,106	25	1,367	129
Clatsop	33,000	43	197	138
Columbia	53,325	220	308	101
Coos	98,435	211	325	184
Crook	137,051	202	221	324
Curry	80,000	35	194	349
Deschutes	238,000	107	725	286
Douglas	104,438	185	920	95
Gilliam	45,000	284	94	119
Grant	249,900	215	211	587
Harney	280,095	567	94	424
Hood River	41,000	36	167	202
Jackson	178,423	240	701	190
Jefferson	99,634	211	214	234
Josephine	100,000	6	531	186
Klamath	336,000	103	736	401
Lake	213,347	324	276	355
Lane	110,330	196	1,205	79
Lincoln	124,187	156	174	376
Linn	356,106	135	959	326
Malheur	150,000	720	388	135
Marion	244,000	240	857	222
Morrow	56,000	446	360	69
Multnomah	106,882	10	364	286
Polk	65,500	275	220	132
Sherman	38,750	256	113	105
Tillamook	58,200	58	268	178
Umatilla	166,352	923	495	117
Union	43,000	369	187	77
Wallowa	94,850	344	95	216
Wasco	147,475	340	263	245
Washington	288,691	310	839	251
Wheeler	32,000	139	54	166
Yamhill	66,748	294	370	100
TOTAL	4,815,964	8,895	14,897	202
Urban Counties [16]	1,353,145	1,984	6,454	160
Rural Counties	3,462,819	6,911	8,443	226

Sources: DOGAMI survey of county road departments and ODOT 1993 Oregon Mileage Report. Mileage includes only roads under county government jurisdiction.

[16] The ten counties with the highest number of households per square mile in 1993. They are Benton, Clackamas, Columbia, Jackson, Lane, Marion, Multnomah, Polk, Washington, and Yamhill Counties.

How Is Road Mileage Distributed in Oregon?

We estimate that Oregon had 74,987 miles of improved roads in 1993. Over half of this mileage was made up of gravel roads, and 26,377 miles were asphalt roads. Most of the gravel roads were under the jurisdictions of the BLM and USFS. The state, counties, and local governments managed most of the asphalt roads. County road departments were responsible for the majority of the 9,296 miles of oil mat roads in Oregon. Concrete road mileage was less than one percent of the state's total.

State roads accounted for one out of every ten miles in Oregon. County road departments managed three out of every ten miles and were the largest type of jurisdiction. Other significant jurisdictions were the BLM, USFS, and local governments.

Two thirds of all the roads are in western Oregon. This region also had two thirds of the gravel road mileage. Gravel roads are used in western Oregon for logging in areas with steep terrain and wet climates.

On Table 1.10, road mileage by surface type and jurisdiction is shown. Most of this information comes from the 1993 Oregon Mileage Report published by ODOT. Each year, ODOT asks various jurisdictions around the state for their road mileage. In addition to the ODOT data, we included our own estimates for miscellaneous roads. This small amount of mileage includes streets that are not under any jurisdiction but are still used by the public.

Table 1.10

1993 Road Mileage in Oregon

Jurisdiction	*Gravel*	*Oil Mat*	*Asphalt*	*Concrete*	*Total*
State Highways	31	0	7,110	344	7,485
State Forests & Parks	2,515	2	184	0	2,701
County Roads	8,895	5,892	8,957	48	23,792
Local Roads	2,912	1,226	6,729	291	11,158
BLM	13,444	1,338	25	0	14,807
USFS	9,155	557	2,244	0	11,956
Miscellaneous Roads	1,300	240	800	7	2,347
Other Government Roads	367	41	328	5	741
Total	38,619	9,296	26,377	695	74,987
Eastern Oregon	6,263	1,159	3,360	102	10,884
Central Oregon	6,826	2,015	5,125	10	13,976
Western Oregon	25,530	6,122	17,892	583	50,127

Sources: DOGAMI estimates for miscellaneous roads and ODOT 1993 Oregon Mileage Report.

Is Recycling Going to Reduce the Need for Mining?

Recycling is reducing Oregon's need for virgin aggregate. We estimate that 3.8% of Oregon's aggregate in 1993 came from recycled materials. Our forecast shows this more than doubling to 8.6% by 2050.

The impact of recycling is large. In our forecast, recycling reduces virgin aggregate consumption by 188.9 million tons for the years 2001 to 2050. With the average commercial mine producing 83,159 tons annually[17], recycling eliminates the need for 45 operating mines each year. Over the fifty-year forecast, recycling cuts back the need for over six square miles of landfills.[18]

There are limitations to recycling. Technical issues related to processing and use are major hurdles. Recycling is also largely unresponsive to prices. For instance, people do not tear up old pavement for recycling because the price of aggregate goes up.

Low volume is another constraint. Normally, recycling is economic only if large quantities are in one location and processed at once. Because most sources are small, there tends to be more recycling in cities. They have larger and more concentrated waste streams.

High stockpiling costs hinder recycling. It costs money to collect, truck, and process recycled materials. These expenses cannot be recovered until the materials are sold. Sales, however, depend on new construction projects. Often, there are long time lags before sales. As a consequence, recycled materials can remain stockpiled for extensive periods. The investment needed to finance these inventories is a burden especially in rural areas.

The most important limitation is the difference in gross volumes. Oregonians simply use far more aggregate than they can possibly recover from waste streams. Currently, daily aggregate use in Oregon is 96 pounds per person. That is well above the amount of solid wastes generated.

Roads are the largest source of recycled aggregate in Oregon. We estimate that repair and maintenance work on paved roads generate 633,000 tons of recoverable wastes each year.[19]

While recycling has limitations, it is a growing activity. New, innovative ways are being introduced each year for collecting, processing, and using wastes. Recycled materials are finding more acceptance as alternatives to virgin aggregate by the construction industry. Growth is also being fueled by rises in landfill disposal costs, virgin aggregate prices, and trucking rates. Recycled materials will never dominate the market, however. Ultimately, we believe the use of recycled materials will level off at about 10% of total aggregate consumption. The percentage will be higher in cities but lower in rural areas.

What Materials Are Recycled?

The most important materials recycled as aggregates are reclaimed asphalt pavement (RAP) and recycled concrete aggregate (RCA). Other sources include building debris, fill and rock from excavations, nickel smelter slag, steel slag, shredded old tires, old sanitary porcelain, and broken glass. Sand and gravel that are used on streets for ice control are recycled by some cities.

RAP is a popular material in Oregon. It is a valued resource. A ton of RAP contains about $8 of aggregate and asphalt. Besides economizing on materials, road crews using RAP also save on disposal costs.

The old asphalt in RAP is brittle. It is an inferior substitute for fresh asphalt. Contractors correct this problem by blending in plenty of fresh asphalt. Typical mixes contain 15% and 20% RAP.

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[17] In 1993, the average active commercial mine produced 83,159 tons of aggregate.

[18] This assumes that the average landfill depth is 20 ft.

[19] According to Chuck Marek, Technical Director of Vulcan Materials Corp., 40 million tons of waste is produced annually from the repair and rehabilitation of pavements in the U.S. (*Stone Review*, August 1994, p. 24). Oregon's share in proportion to its road mileage is 633,000 tons.

Hot-mix asphalt plants that use RAP need special equipment for controlling emissions. Heating RAP is a smoky process. RAP is more commonly used in urban areas, where volumes are high enough to cover the costs of this added equipment.

Occasionally, road crews will resurface asphalt roads using in-place methods. They use either heat or mechanical means to remove the top layer of pavement. This RAP is then mixed with new materials and put back down in a continuous process. RAP makes up over 90% of the aggregate used. Because of the high RAP content, additives may be needed so that the new pavement has the desired characteristics.

Many paving companies and public road departments use RAP whenever they can. Some customers, however, question its durability. Specifications for paving projects often restrict or even prohibit the use of RAP. Sometimes these are justified, but at other times they are not.

Besides being used in pavement, RAP is an excellent substitute for base rock. No special equipment is needed for this end use.

Recycled concrete aggregate (RCA) is recovered from old concrete pavement, masonry block, and torn-down buildings. Old concrete is usually found mixed in with other construction debris. Steel, copper, wood, bricks, and other materials are separated from the concrete. Some of these materials are quite valuable. Once they are removed, portable equipment is used to crush the old concrete into acceptable sizes. This processing is often prompted by high disposal costs for construction debris. Recycling reduces the volume of material sent to landfills.

RCA is a good substitute for crushed rock. It is not as valuable as RAP, however. While RAP contains usable asphalt, the cement in RCA cannot be recovered in its original form. RCA also is typically found in small quantities at any one site. It is most likely to be recycled in cities where there are markets for the product, large concrete structures, and high disposal costs.

Clean building debris is sometimes used as a substitute for virgin aggregate fill. This activity is driven mostly by the high disposal costs for building debris. For this reason, it is more common in urban areas. Debris from torn-down buildings may be used as fill on site, be trucked to other job sites, or be sent to old aggregate mines. Old mines that are in areas where real estate prices are high can be refilled with clean debris. Once filled, the recovered land may be used for a park or even as a building site.

Soil, sand, and rock removed from excavations can be used in place of virgin aggregate from mines. Excavated material that is used as fill elsewhere on a job site is called native fill. Technically, this is not considered recycling, since it is part of the process of site preparation, where natural materials are moved. Recycling does occur, however, if the excavated material is a waste product that could go to a landfill but is diverted for use at another construction site.

Various industrial and municipal wastes are recycled and used for aggregate. To be economical they must be clean and safe to the environment, come in large quantities, and have the physical properties of natural aggregate. Nickel smelter slag from the town of Riddle in Douglas County, Oregon, is a particularly good aggregate source.

Can We Find Ways to Replace Aggregate?

Aggregate is a difficult material to substitute because few of its alternatives are cost effective. However, all commodities, no matter how inexpensive, face some substitution. For aggregate, only a fraction of the total market is vulnerable to substitution. These cases tend to be limited to a few specific end uses and circumstances. In an individual case the savings are often small, but collectively they can be significant.

For most of its uses, virgin aggregate provides strength and bulk at a low cost. Only a few recycled materials and types of native fill share these features. Other substitutes lack some of the desirable characteristics of aggregate, but instead they provide other benefits.

The most important benefit is reduced labor cost. More expensive materials will be used if they eliminate worker time on the job. The cost of the displaced aggregate is often an insignificant factor in the substitution.

For example, while aggregate may be 10% to 20% of the delivered price of concrete, most of the cost of using it is in the labor needed to form the concrete. In the end, aggregate is only a minor part of the total cost.

For some applications in buildings, concrete competes directly with steel. If an architect chooses steel over concrete, the amount of aggregate needed to construct a building is reduced. Although the price of aggregate may not have had any impact on the decision, it gets substituted.

Suppliers of building materials are always introducing new products. Some of these lessen or even eliminate uses for aggregate. For instance, innovations in glass have led to losses in aggregate consumption for exterior walls. High-strength concrete has replaced regular concrete in some applications because of its desirable engineering characteristics. Projects made with high-strength concrete use less aggregate.

A few new technologies and products directly target aggregate substitution as a major reason for their development. Lime-treated base, for example, is growing in popularity especially in areas where crushed rock is expensive. In this method, lime, sand, clay, and native soil are mixed together and compacted. Asphalt or concrete pavement is placed on top. No base rock is used. The method works well, but technical problems limit its use to special situations.

Geotextile fabric is a common alternative to base rock in road construction. A geotextile fabric allows water to drain into soil while keeping crushed rock from sinking into the ground. It effectively reduces the amount of crushed rock needed.

Some substitutes do not replace aggregate but simply extend its useful life. New plastic-based chemicals are being used on gravel roads and in asphalt pavements. These improve durability and reduce the amount of aggregate needed for maintenance and repairs. Durability can also be enhanced by use of thicker layers of asphalt pavement or even concrete in place of asphalt.

The construction industry is innovative. The materials and methods used today are quite different from those used just two generations ago. Lowering labor costs is the main driver of this change. Substitution of aggregates is usually an unintended consequence.

Innovation will cut into future consumption, but this will occur at a very slow pace. Aggregate is simply inexpensive relative to its benefits. For many of its uses aggregate does not face serious competitive challenges.

How Important Are Shipping Costs?

In 1993, aggregate sold for an average mine-gate price of $4.39 a ton in Oregon. This figure comes from our mining industry census. The price does not include shipping costs. We estimate, however, that the average delivery charge for aggregate shipped by truck was $1.62 a ton. The total delivered price is $6.01 a ton.

We estimated the shipping cost because the size, complexity, and lack of readily accessible data made direct data collection impractical. There are 1,074 intrastate sand and gravel carriers alone in Oregon.[20] Several thousand crushed rock, captive, interstate, and other types of truckers also ship aggregate. Very few can calculate their average delivery distances and charges. We had to rely instead on informed opinions about normal delivery conditions in Oregon.

[20] From a computer printout of sand and gravel carriers by zones supplied by Arnie Chinn of the Oregon Public Utility Commission.

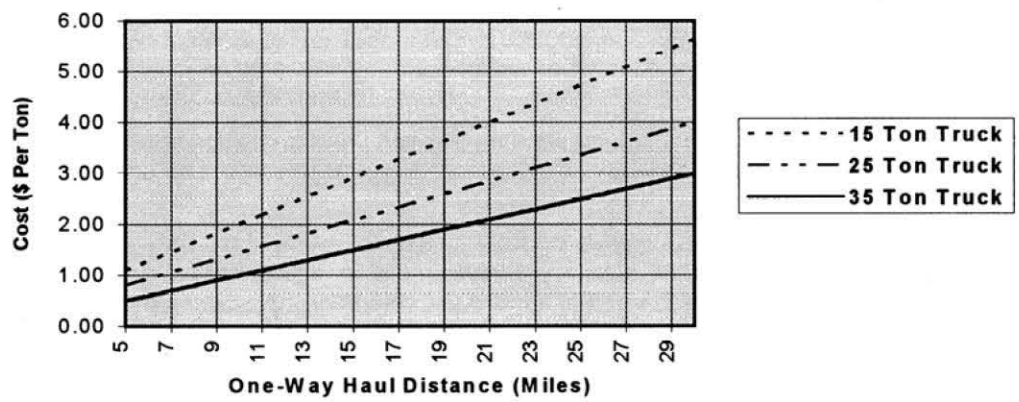
We called several independent truckers and mines and asked them what they charged for loading, unloading, and hauling aggregate. We were told that a typical one-way shipment was 10 miles. Respondents said that their charges depend on the driving time, the size of shipment, and the type of truck.

Our $1.62 estimate is based on an average truck load of 20 tons. We assume that the typical truck travels 35 miles per hour over its route. At 10 miles each way, a round trip takes over 34 minutes. Loading adds five minutes to each trip. Unloading takes another four minutes. The total round trip time is just over 43 minutes. From our informal survey, we estimated that the average truck costs $45 an hour. That includes fuel, labor, and maintenance. A single round trip, therefore, costs $32.46. Dividing that by 20 tons gives us a shipping charge of $1.62 a ton. About 34 cents of that are the costs of loading and unloading.

Trucking costs vary considerably, depending on circumstances. Truck capacity, for instance, has a big influence on delivery costs. Truck capacities range anywhere from one to over 30 tons. A market study of hauling rates for sand and gravel in the Puget Sound region of Washington state shows how important truck capacity is to delivery cost.[21] According to the study, in 1990 shipping a ton of sand in a truck carrying 15 tons cost approximately twice as much as in a truck hauling 35 tons. Figure 1.2 illustrates the relationship between distance, cost per ton, and truck capacity.

Figure 1.2

Contract Trucking Costs For Hauling Sand and Gravel as a Function of Distance in the Puget Lowland During 1990



Travel time directly affects shipping costs. Traffic hurts the productivity of trucks. In our estimate, if we assume that congestion slows trucks to 30 miles per hour, the shipping cost estimate goes up to $1.84 a ton. Road congestion is one reason why shipping costs are higher in urban areas.

Distance affects trucking costs. If we increase the distance in our estimate between a mine and its customer to 32½ miles, shipping costs go up to $4.39 a ton. That is double the 1993 mine price of the aggregate. For every extra mile between a mine and a consumer, our estimate of trucking costs rises by 12.9 cents a ton. Actual costs will vary depending on local conditions.

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[21] White, W.W., III; Stebbins, Scott; Hillman, and Thomas, 1990, *Puget Sound Region Sand and Gravel Market Study*: U.S. Bureau of Mines Report BIA 64–III, 1 v.

Shipping costs have a dramatic effect on competitiveness. For instance, consider the case of two mines competing to supply crushed rock to a construction project. If one of the mines is ten miles farther away from the project, it will very likely lose out to its competitor, because the shipping charges would add $1.29 per ton to the delivered price.

There are exceptions. Some mines can compete well beyond their local markets. They can do this if they produce a highly desirable grade of aggregate, have unusually low mining costs, or have access to low-cost shipping. Mines on interstate highways, for example, can sometime afford to haul aggregates for long distances because their trucks travel at highway speeds. All of these, however, are exceptions.

According to our census, over 92% of Oregon's aggregate production in 1993 was delivered by trucks. We estimate that mines originated 2,244,843 truck loads in 1993. We believe there were another 204,000 loads coming from out-of-state mines and recycled-material sources.

Our estimate puts the cost of trucking at 16.2 cents a ton mile. This includes the expense of loading and unloading. A ton mile is the cost of shipping a ton of aggregate one mile. While trucking is expensive, it has one major competitive advantage: it is flexible. Trucks can deliver between any two points on short notice. They can also economically ship small quantities.

Barges haul 5% of the aggregate coming from Oregon's mines. Most of the traffic is on the Willamette River, where calm waters allow for simple deck barges to make local deliveries. Even though barges are suitable for long-distance shipping, only one is currently doing so. On the Columbia, there is one barge making long-distance deliveries between Boardman and Portland.

Depending on the design, barges carry anywhere from 1,000 to 3,000 tons of aggregate. The cost, including unloading, runs between one and two cents a ton mile. While inexpensive to operate, barge systems for aggregate often require a very large investment in vessels and port facilities. On the Columbia River, for instance, you need special high-walled barges to protect against the high winds and swells.

Railroads shipped 2% of Oregon's aggregate in 1993. Two mines accounted for most of the traffic. One moved rock from a mine in an isolated area of Washington County to a city near Portland. The other mine shipped high-quality railroad ballast from Baker County.

A single rail car holds 100 tons of aggregate. Loading and unloading costs about 75 cents a ton. Shipping costs are negotiable and vary with distance. A typical rate would be around 3.5 cents a ton mile.[22]

Like barges, railroads are handicapped by their inflexibility. Rarely are they adjacent to both mines and construction sites. A substantial investment in equipment is normally required. Aggregate usually has to be transferred at some point onto trucks. Anytime a ton of aggregate is transferred, about 34 cents a ton is added to its final delivered price.

Shipping by ocean freighter is another way of delivering aggregate, although it is not presently done in Oregon. Using ocean freighters is feasible because of back-haul pricing. Ships are often empty when they come into ports to pick up loads. Knowing they will make a profit on those loads, the ships can offer low rates if they can find anything they might deliver into the port. These low-cost arrangements are called back-haul rates. Currently, empty ships come into Portland to pick up soda ash, potash, and other mineral commodities. The port has facilities that can be modified to handle aggregate imports.[23]

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[22] From a phone conversation with Ed Immel, ODOT State Railroad Planner.

[23] From conversations with the Port of Portland.

What Happens if There is a Shortage of Aggregate?

Local aggregate shortages occur in Oregon from time to time. Usually, they are caused by one or two large construction projects that overload local mining capacity. Mines can sometimes increase their capacity by adding equipment, but this takes considerable time and money. For the most part, mine capacity is fixed and sudden increase in demand can create local shortages.

One way of dealing with such a shortage is to bring in supplies from neighboring markets. Buyers bid up the prices of locally produced aggregate. This makes it practical to ship aggregate in from other markets. To cover the costs of trucking in aggregate another 15 miles, local prices would have to increase about $1.93 a ton. If these costs are all passed down to consumers, the average household would see its cost of living increase by $87.67 a year.[24]

Consumers can delay or change their construction plans because of shortages. Few consumers will react in those ways, however, because aggregate is usually a small part of the total cost of construction. When it does occur, it is usually on projects such as roads and parking lots where aggregate usage is very high.

Sometimes, local shortages force contractors to use grades of aggregate they would normally avoid. Projects made with poor-quality aggregate often cost more to build and lack durability. A road made from an inferior grade of crushed rock, for instance, will deteriorate quickly and require more maintenance. Ultimately, more aggregate will be used in the long run.

When faced with persistent shortages of local aggregate, builders will pay higher prices for their aggregate and make changes in the way they do construction. This will result in higher construction costs. Some of these costs will be hidden in the forms of higher rents, retail prices, and taxes. Overall, the community's economic competitiveness will suffer. In addition, with plenty of aggregate coming in from other markets, there will be more truck traffic and road congestion in the community.

How Competitive Are Aggregate Markets?

Competition between aggregate producers is often quite fierce. In most markets around Oregon, competition effectively keeps prices in line with production costs. Mines earn fair rates of return, while consumers pay the lowest sustainable prices for aggregates. That is how competitive markets work, but not all aggregate markets are like that.

As noted before, high shipping costs isolate markets and limit competition to local producers. Fortunately, you do not need many producers to have a competitive market. Two or three significant producers (assuming they do not collude) are enough to promote competitive pricing.

Competitive pricing is important. It assures that consumers pay prices that reflect production costs, business risks, and fair rates of return. At times when demand is weak, the cost of producing an extra ton of aggregate is low, because there is plenty of extra mining capacity and labor around. Prices mirror this condition and fall. When demand is high, both labor and capacity are running full-out. The cost of supplying an extra ton rises and prices go up. In competitive markets, therefore, prices move up and down with demand. Consumers, over the long run, benefit by getting the most for their money. The economic term for this is efficient pricing.

Problems arise when a community has only one mine or if the largest producer has an overwhelming share of the market. In some, but not all, cases where this occurs, the largest producer exercises market dominance.

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[24] Total aggregate consumption in 1993 was 53,273,017 tons, and there were 1,171,966 households in Oregon. Dividing those two gives us an average consumption of 45.46 tons per household. Using the trucking cost estimates from the "Shipping Costs" section of this report, the incremental costs of trucking a ton of aggregate 15 miles is just under $1.93 a ton. Multiplying that by the tons consumed per household gives us a total of $87.67.

A producer takes advantage of market dominance by unilaterally raising prices to levels that are well above normal. In addition, such a producer can make these high prices stick regardless of how much demand there is for aggregate. Other local producers, if there are any, are too small to do anything about it. Meanwhile, mines in neighboring markets are far enough away so that high shipping costs keep them from bringing in aggregate. The result is a monopolistic market structure.

Three conditions foster monopolistic structures. First, one producer must have a large share of the market. Second, the product must be hard to substitute. Finally, the dominant producer has to be shielded from new competitors.[25]

Monopolistic market structures are not necessarily bad. It depends on how the dominant producer is shielded from competition. Some markets are too small to support more than one producer. Others, because of geologic conditions, have just one good aggregate mining site. Wherever these conditions exist, in practical terms, there is room for only one producer. What results is called a natural monopoly.

In a natural monopoly, a community usually pays higher prices for aggregate compared to larger competitive markets. However, if the community breaks up its natural monopoly, it will likely be worse off. It would replace one mine with several smaller and less efficient mines. With higher production costs, the smaller mines could end up charging more for their aggregate than the natural monopolist.

Monopolistic market structures can be damaging if the dominant producer is protected by an artificial barrier to entry. A barrier to entry is anything that keeps new competitors out of a market. Unlike natural barriers such as small market size and unfavorable geology, artificial barriers have little to do with the business merits of operating a mine. Artificial barriers keep competent and capable producers from establishing themselves in communities where resources and demand are sufficient to support new mines. Typically, the barrier is political.

If a dominant producer sets unreasonably high prices, competitors should be attracted to the area. Sometimes, however, communities shield dominant producers from this threat by making it nearly impossible for competitors to establish new mines.

Siting a new mine is an expensive, difficult, and uncertain process. Political systems can protect communities from careless or poorly planned mining operations. Such systems, however, can be used to block competent new competitors from entering the market. By being too restrictive, communities create situations, often unintentionally, that let dominant producers charge excessive prices. In more extreme cases, dominant producers will actively engage in predatory exclusionary tactics that can even lead to the corruption and misuse of political institutions.[26]

If protected by an artificial barrier, a dominant producer can charge prices that are substantially higher than those that would exist under free competition. This type of monopolistic market structure is bad for a community. The excess profit earned by the dominant producer comes at the expense of consumers. The local economy operates less efficiently. Construction costs are higher than they should be. This, in turn, hurts the local business climate and makes housing less affordable. Higher aggregate prices affect government budgets for schools, roads, irrigation districts, and other public construction projects. Total employment suffers.

Another characteristic of dominant producers is their tendency to maintain excess capacity. They can control either prices or quantities in local markets, but not both. Typically, they will choose to set prices artificially high. They do this by restricting supply. The producers make more money by operating at a lower level of capacity than they would under competitive conditions. Having extra capacity also allows them to argue that new mines are unnecessary in the community because there is plenty of available capacity for growth.

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[25] Chamberlin, E.H., 1962, *Theory of Monopolistic Competition, 8th ed.*

[26] Scherer, F.M., and Ross, David, 1990, *Industrial Market Structure and Economic Performance.*

There are no simple rules for identifying a monopolistic market structure. The most visible signs show up in prices and market shares. Prices in these markets generally do not fluctuate with changes in demand. They also are unusually high compared to neighboring markets. In all cases, dominant producers have large market shares.

A producer may get high prices for reasons that have nothing to do with unfair competition. For instance, a mine may sell a highly desirable and hard-to-find variety of aggregate. The most common reason for high prices, however, is that they are just a reflection of high operating costs. Usually this is due to adverse geological conditions. Many aggregate deposits in Oregon, for example, are rich in clay. The clay has to be removed during processing because it is a harmful constituent to the aggregate. Removing clay is an expensive step. High costs can also exist in small markets because mines do not have the benefits of large-scale production.

What Can be Done to Encourage Competitive Pricing?

Competitive pricing has both economic and social benefits. Ensuring it can be difficult, however. The best way to encourage competitive pricing is to have several significant producers. This is easier said than done, and in some markets it may be impossible. Yet, there is an alternative way to achieve competitive pricing, even if there is only one producer in a community.

A dominant producer who has no fear of attracting new competitors in her or his own market can raise prices up to a level called the limit price. This price is just below what it would cost consumers to buy aggregate from another market and have it shipped in. The limit price places an upper boundary to what a dominant producer can charge. Still, it leaves the community paying a large premium for its aggregate. If the nearest competitive market is 15 miles away, for instance, a dominant producer could charge a premium of up to $1.93 per ton.[27]

Competitive pricing is least likely in markets where the geology limits a community to one mining site. In this type of natural monopoly a producer cannot be threatened by new competitors because the area has no other comparable mining sites. The producer can use limit pricing.

If the community has ways to reduce shipping costs, it can lower the limit price. This may be done by allowing larger trucks on the roads or, if possible, by promoting rail or barge shipments. The community can also strongly advocate recycling. None of these options are particularly strong and they are applicable to few communities.

Where natural monopolies are caused by small market size, communities have more leverage. They can pressure their producers by remaining open to the siting of new mines by outside competitors. Having a new competitor enter a small market with natural monopoly would be an extremely unfavorable event for an established producer. For that reason, a monopolist would likely keep prices in line with competitive markets to avoid attracting unwanted competition.

In markets where there are no natural monopolies, communities usually have at least two significant and separately owned aggregate mines. We also see markets with just one dominant producer. These producers may have become dominant because they were more efficient than any of their competition. In some cases, they may have bought out competitors.

Communities with dominant producers and no natural monopolies are best served if they remain open to siting new mines by other producers. If the community does not do this, the dominant producer could raise prices far above competitive levels without the risk of attracting competition.

Policies encouraging competition do not have to lead to the development of new mines. They merely have to create a credible threat of new capacity that the dominant producer cannot control or block. Dominant producers will set prices close to competitive levels if the risk of new competition is great. Otherwise, they can set higher prices.

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[27] $1.93 is the incremental cost of trucking aggregate an additional 15 miles. This cost is based on the assumptions outlined in the "Shipping Costs" section of this report.

In the worst-case scenario, prices will equal the limit price. If the producer dominates neighboring markets, the limit price can be quite high. The producer might also extend this market power into downstream businesses such as concrete, asphalt, and contracting.

Another method that might ensure competitive pricing is to pre-permit an area for mining. A large site is chosen by producers for its access to markets, environmental suitability, and the quality of its aggregate reserves. They then file a joint environmental impact statement. The community supports the area with adequate roads and planning, which helps minimize conflicting uses. Such a method has been used in Minnesota.[28]

Pre-permitting creates a stable and competitive aggregate market. It also stimulates the growth of related businesses. The downside to pre-permitting is its effect on land prices. The community may actively discourage mining in other areas and force producers to operate only on the land set aside. Doing this creates a scarcity value to mineable land. Companies could end up biding up the price of set-aside land. This, in turn, may raise mining costs and aggregate prices.

What Can Be Done to Conserve Virgin Aggregate Resources?

Conservation can be approached from both the supply side and the demand side. The principal supply-side methods are recycling and setting aside aggregate resources. On the demand side, conservation can be achieved by influencing choices for construction and development.

Virgin aggregate supplies are limited by geology and competing land uses. That is why setting aside land for future mining helps conserve virgin aggregate resources. For this to work properly, the land must contain quality aggregate that can be economically and safely mined. It has to be close, in terms of shipping costs, to where construction is going to occur in the future. Ideally, in any one community, several areas containing a range of aggregate types should be set aside.

Quality is very important. If the deposits set aside contain lower grades of aggregate than are currently being used, problems will arise. Over time, total virgin aggregate consumption will go up simply because more tons will be needed to compensate for the falling quality. Rather than conserving resources, the community could become more wasteful.

During our research, several road departments said that the quality of the aggregate they are using today is appreciably lower than it was in past years. As a consequence, roads are expected to wear out more quickly and require more tons of aggregate for maintenance.

Setting up a system for importing aggregate can help conserve local virgin aggregate resources. This can be an expensive option and may require a public investment for rail or port facilities. There is also a risk of supply disruptions.

Recycling is another way of conserving virgin aggregate. Without any influence from government, recycling will grow in Oregon because of natural free-market forces. Government can help accelerate this growth by encouraging the use of recycled materials on public projects. Governments can liberalize specifications so that contractors can use more recycled aggregate. They can support special test projects. ODOT, for example, has strongly backed leading-edge recycling projects.

On the demand side, communities can influence construction choices by zoning, tax policies, and incentive programs. For instance, by allowing the development of two-family homes instead of single-family homes, a community could significantly reduce its virgin aggregate use.

Some communities use over a fifth of their aggregate to replace old buildings. This occurs in both rural and urban areas. For example, we commonly see new stores being built on the outskirts of towns, while downtown stores remain vacant. This happens because it is often cheaper to construct and occupy a new building than it is to renovate an old one. This same pattern is repeated in housing; in this case, however, the impetus is a consumer preference for new homes.

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[28] Phone conversation with Mr. Brian Benson of Shelbourn County, Minnesota, Planning and Zoning.

"Greenfield" projects use the most virgin aggregate. A greenfield project is built on a site where no structure existed before. Because of this, large amounts of aggregate are needed for utilities, roads, parking, and other site work.

"Brownfield" projects use less aggregate. Here, construction takes place on land where an old structure was torn down. The site may already have utilities, roads, sidewalks, water lines, and places to park heavy construction equipment. Using these existing features reduces the need for aggregate. Also, old concrete and asphalt from the demolished structure can be recycled. This further cuts the need for virgin aggregate.

Renovations use the least amount of virgin aggregate. Savings come not only from the re-use of existing site features, but also from the re-use of the old structure itself. Renovations, however, can be costly and technically challenging. According to Jack Donovan, construction manager for PCL Construction Services, "Renovation is always more difficult than starting from scratch."[29]

While the economics of commercial and residential construction tend to favor greenfield projects, there is a downside for communities. Greenfield projects use considerably more virgin aggregate. Communities encouraging greenfield construction must consider where they are going to get the virgin aggregate to support it.

Incentives for rehabilitating old structures and brownfield developments have an often unrecognized benefit of conserving virgin aggregate resources. Among the possible incentives a community may use are zoning-law changes, tax benefits, or the building of public parking areas in downtown shopping zones.

Communities can reduce their need for virgin aggregate by having good public transportation systems. They reduce the need for roads and parking areas. As much as a third of the aggregate used in nonresidential buildings goes into parking lots for private cars.

Commuter rail systems provide the greatest savings in aggregate consumption of all the public transit options. Rail systems use large amounts of aggregate when built, but require relatively little for maintenance. Buses, on the other hand, cause road damage.

How Does the Forecasting Model Work?

The Department of Geology and Mineral Industries built a forecasting model for every county in Oregon. The models all have the same structure, but operate with different sets of input data that reflect the unique characteristics of each county. The models are designed to forecast long-term trends for a 50-year period beginning in 2001 and ending in 2050. They contain large amounts of data and many equations.

There are four parts to each county model. The first contains basic input data about the county. The next part uses these data to project a county's need for housing, roads, and other construction. This is followed by forecasts of usage rates. A usage rate is the amount of aggregate consumed for a given unit of construction. For example, the usage rate for schools is measured in tons of aggregate needed to construct 1,000 square feet of a new school building. The final part of the model multiplies the construction and usage-rate forecasts to give us projections of total aggregate consumption.

The models use demographic forecasts to predict aggregate consumption. Demographic forecasts consist of projections for population by age group, numbers of households, and personal income. Users can change any of these to suit their own opinions about a county's growth prospects. Users can also change the equations that convert the demographic data into aggregate forecasts.

Besides demographics, other data are fed into the models that help describe differences between counties. For example, there is one that indicates whether or not a county has a commercial airport. It is used in an equation that forecasts the construction of airport buildings.

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[29] *Pacific Builder and Engineer*, April 24, 1995, p. 12.

Each model divides a county's construction activity into 33 categories. These include schools, gravel roads, high-rise apartments, bridges, parking garages, manufacturing plants, and stores. Building construction is measured in the models in terms of thousands of square feet. Other types of construction, like sewers and dams, are expressed in thousands of 1987 dollars.

The term "1987 dollars" means that the cost of the construction is stated in what it would have been if it had occurred in 1987. That way, no matter what year we are looking at, construction values are in the same dollar terms. This is a standard forecasting practice, and it eliminates distortions caused by inflation. The year 1987 was chosen for convenience. The choice has no practical effect on the aggregate forecast.

F.W. Dodge is the source for most of the construction data. We used the historical data on construction from F.W Dodge to make our own forecasts. F.W. Dodge is the construction industry's leading statistical analysis firm. Nearly all major construction companies report data to it. F.W Dodge is the only source of detailed construction data for Oregon's counties. F.W. Dodge claims to capture 90% of the new construction in Oregon. Our forecast adjusts for this by adding 10% to the data.

Housing presented special problems for our analysis. Unfortunately, there is no single source of housing data. We had to combine data from several sources and make some of our own estimates. Much of the historical data came from F.W. Dodge, the U.S. Census, and the Oregon Association of Manufactured Homes. We used this to create our own balance sheet showing the inventory, new additions, losses, vacancies, and other factors necessary to predict housing construction. Housing was divided into seven categories ranging from high-rise apartments to manufactured homes.

Most of the information on roads in the models comes from ODOT. We adjusted ODOT's figures to account for small numbers of miscellaneous public roads. The road data were then divided up according to the type of surface. The forecast for road mileage is driven by the changes in the number of households and population densities of counties.

The model does not forecast private logging road mileage, but it does capture the aggregate use by this sector. This is done by comparing aggregate use to the sizes of timber harvests.

For BLM, USFS, and State Park and State Forestry Department roads, a different approach was used. From our base year of 1993, we assumed that state forest and park road miles will not change. For BLM and USFS gravel roads, we assumed that their mileage will be cut to 50% of the level reported to ODOT in 1993 by the year 2000.

Aggregate usage factors are important to the models. There is one factor for every category of construction. Most are single values that apply to all the years in the forecast. Others change from year to year, depending on economic conditions.

Since there are no published sources for usage factors, we had to make our own estimates. This was a very difficult task, because construction work is divided between many individual contractors. At most construction sites, no single person buys all the aggregate used. In addition, aggregate itself comes in different forms such as asphalt, concrete, precast products, and masonry sand. Those in the construction industry that we contacted could not readily tell us how much aggregate is used on their projects.

Mr. Joseph Gehlen, of Kramer Gehlen & Associates, volunteered his time to help us. Kramer Gehlen & Associates is a major structural and civil engineering consulting firm based in Vancouver, Wash. The firm works on a wide variety of large construction projects in Oregon and other parts of the west. Gehlen helped develop estimates for usage rates in typical structures.

Once we had factors for structures, we contacted people that specialize in site work. Before a building goes up, large amounts of aggregate go into site preparation. This includes sidewalks, entrance roads, sewers, water mains, and drainage areas.

Several construction companies then suggested we include extra amounts of aggregate for staging areas. A staging area is a place where contractors keep their heavy equipment and supplies on site. It is covered with a thick layer of crushed rock. This helps keep mud off equipment and supplies. It also prevents heavy equipment from sinking into the ground. Additional rock is used for temporary access roads. For large buildings, staging areas and temporary roads can be among the largest single uses of aggregate. The need for all this rock is highest in western Oregon, where construction activity extends into the wet winter months.

For roads, usage factors were used that vary depending upon the type of road, a county's population density, and its growth. When applied to 1993 county road mileage statistics, the estimate for aggregate consumption was within 5% of actual amount reported in the county road department survey.

Usage factors are a crucial part of the model, but they are highly variable. Two structures built for the same purpose and of the same size can use vastly different amounts of aggregate. In addition, if a building goes up on a brownfield site, it will use far less aggregate for site work than one built on vacant land. The factors in the models are broad averages. They can be changed to suit differences of opinion and unique circumstances.

Our models include several other categories of aggregate consumption. Railroad ballast is one of these. Ballast is the rock on top of which track is laid. New rock is added from time to time and it is a significant end use. Our forecast is based on the number of miles of main-line and short-line track in each county. Another important category is aggregate used on farms and ranches, and in other agricultural settings. We estimated this end use by factoring in the number, type, and average size of farms in each county.

We included three catchall categories for residential, nonresidential, and infrastructure construction. These account for repairs, maintenance, improvements, and other work not counted elsewhere in the models. We know that large amounts of remodeling and other types of construction are not captured in F.W. Dodge's data. These include everything from putting in of new patios by homeowners to having stores repave their parking lots. We forecast aggregate consumption for these by taking a percentage of both new construction and estimates of base level use in each county.

A miscellaneous category measures nonconstruction uses. It equals approximately 5% of statewide consumption. That percentage varies by county. Some nonconstruction uses are landscaping, jetties, hiking trails, stream reparations, cemeteries, golf courses, and landfills.

The models take into account technological improvements that yield efficiency gains. These are improvements in construction methods and materials that occur slowly over time. We used a very conservative 0.1% rate. That means, if there are no other changes from one year to the next, aggregate consumption will fall 0.1% because of new methods and materials.

We applied the 0.1% rate equally on all end uses except roads. An exception was made for roads because several road departments told us they are using or will be using lower grades of aggregate. They expect the growing scarcity of high-quality rock to lessen the life expectancy of pavement, and that will offset any technological improvements. Unlike other end-use categories, the majority of aggregate used on roads goes into maintenance rather than new construction.

Recycling is forecast by taking a percentage of total aggregate consumption. The percentages used are rough estimates by county, and they rise gradually each year. The difference between total consumption and recycling is the forecast for virgin aggregate use.

The results of the models were checked against actual county consumption data derived from the 1993 mining census. The comparisons were very close. Having actual data allowed us to refine the usage factors and recycling percentages used in the models. We were also helped by county road departments, ODOT, F.W. Dodge, studies for other parts of North America, reports from national aggregate producers, contacts in the construction industry, and various aggregate consumers in Oregon.

What is a Long-Term Model?

A long-term model forecasts major trends far out into the future. It essentially takes projections of population, income, and demographics and converts them into forecasts for a particular activity like construction.

Long-term models do not consider short-term factors. Our model, for instance, does not take into account interest rates, office vacancy rates, or tax incentives. All of these affect construction activity, but they cannot be accurately predicted beyond a few years, and their influence is often short lived.

Construction is a cyclical business, which can deviate widely from long-term trends. On the county level, these deviations can be extreme because of the bulky nature of construction projects.

A single project can have a dramatic effect on a county's total construction activity. Structures are not built at rates directly related to a county's needs. Instead, there can be long periods of no new buildings followed by a year with one large project. Construction may wait until there is enough pent-up demand to merit development. Some structures, like manufacturing plants, are usually economic only if they are built on a large scale.

For example, a town may see its school-age population rise by 30 children a year for five years in a row.. Historically, in Oregon we have added 230 square feet of new school buildings for every new school-age child in the population.[30] A town with 30 more students needs 6,900 more square feet of schools. That town probably would not build any, however, because that amount of space is simply too little.

By the fifth year, demand will have built up, and they need space for 150 children. A 34,500 square foot school is probably both warranted and practical. The result is no school construction for four years, followed by a school for 150 built in the fifth year. This creates an irregular pattern of construction.

A long-term model would not recognize this pattern. Instead, it would forecast the construction of 6,900 square feet in each of the five years. A long-term model projects the average need for new construction. It does not capture cyclical behavior.

Why Did You Choose A Long-Term Model For This Research?

Ideally, to track an industry, you want to use a short-term model to forecast the first five years and then a long-term model for later years. For this report, DOGAMI required a forecast that would help predict the need for aggregate mining. Since aggregate mines normally have operating lives that extend for decades, our interest was in knowing how much virgin aggregate a county would consume in the long run. We, therefore, chose a 50-year forecast.

A short-term model has a different and more complex structure than a long-term model. Short term aggregate models incorporate known construction plans for roads, hospitals, dams, schools, and other projects. They also factor in economic data such as construction financing costs, commercial rental rates, and office vacancies. Building such models is a costly and time-consuming undertaking.

Short-term models would give us forecasts for the years 1996 through 2000. This, however, provides us little if any information for making long-term projections.

Overall, the cost of building short-term models far exceeds the benefit.. Those wishing to do short-term forecasts are strongly advised not to use long-term models for that purpose. This would be an inappropriate application. Long-term models simply cannot account for cyclical factors that have a big influence on year-to-year construction activity.

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[30] This is based on an analysis of F.W. Dodge construction statistics and population data for the period 1978 to 1993 from the Center for Population Research and Census at Portland State University.

Do The Models Understate Peaks And Troughs?

Since long-term models forecast trends, they will understate peaks and troughs. An aggregate consumption forecast for any one year can be substantially higher or lower than what actually occurs. Over several years, actual values will average out close to the levels in a long-term forecast.

One reason for a variance was noted earlier. Large, individual construction projects are irregular events. Even for big counties, a new hospital or semiconductor plant can cause a pronounced peak in aggregate consumption. Once the project is complete, aggregate use will fall below the average long-term level.

There is another reason why the long-term forecasts understate peaks and troughs. The demographic data used to drive the models are, by their very nature, smoothed out.

Long-term demographic projections are trendlike and lack the irregularity of historical data. While we know that fluctuations of population and income will be greater than our forecast suggests, we have no basis for predicting the timing or severity of these swings. Instead, we use projections that reflect average outcomes.

Between 1960 and 1993, Oregon's annual population growth rate ranged from a high of 2.9% to a low of minus 0.8%. The range in our forecast is between 0.5% and 1.5%.

Users of the long-term aggregate forecasts should keep in mind that county demographic data can vary greatly from year to year. Table 1.11 is a list of the lowest, average, and highest annual growth rates in county population from 1960 to 1993.

Small changes in population growth rates have major impacts on aggregate consumption. The annual variations are large. The difference between the lowest and highest growth years exceeds 14% for Wheeler, Gilliam, Morrow, and Jefferson Counties. Densely populated counties, such as Washington, Yamhill, and Polk Counties, all have ranges in excess of 7%.

Table 1.11

Historical Range of Annual Population Growth Rates For Counties From 1960 to 1993

County	Lowest	Average	Highest
Baker	-2.5%	-0.2%	2.6%
Benton	-2.2%	1.9%	3.4%
Clackamas	-0.6%	3.0%	5.4%
Clatsop	-4.8%	0.6%	3.7%
Columbia	-0.6%	1.7%	3.2%
Coos	-4.4%	0.4%	2.6%
Crook	-2.3%	1.5%	4.4%
Curry	-1.7%	1.3%	7.0%
Deschutes	-1.6%	4.1%	10.1%
Douglas	-1.8%	1.1%	4.6%
Gilliam	-7.4%	-1.6%	7.1%
Grant	-4.8%	0.1%	3.3%
Harney	-6.1%	0.1%	4.8%
Hood River	-1.2%	0.9%	4.1%
Jackson	-0.3%	2.3%	4.7%
Jefferson	-1.7%	2.3%	13.2%
Josephine	-3.6%	2.5%	7.7%
Klamath	-1.5%	0.7%	2.8%
Lake	-2.7%	0.1%	5.1%
Lane	-2.9%	1.9%	3.1%
Lincoln	-1.5%	1.5%	7.1%
Linn	-3.3%	1.5%	2.9%
Malheur	-6.4%	0.6%	3.2%
Marion	-2.1%	2.2%	4.2%
Morrow	-3.8%	1.8%	11.7%
Multnomah	-1.2%	0.5%	2.8%
Polk	-3.4%	2.2%	4.6%
Sherman	-5.9%	-0.8%	4.1%
Tillamook	-2.3%	0.6%	3.7%
Umatilla	-2.2%	1.1%	4.6%
Union	-5.5%	0.9%	4.1%
Wallowa	-3.5%	0.1%	3.5%
Wasco	-5.6%	0.3%	3.1%
Washington	-0.9%	4.1%	6.2%
Wheeler	-14.4%	-1.7%	5.8%
Yamhill	-0.9%	2.4%	8.1%
Oregon	-0.8%	1.7%	2.9%

Source: Center for Population Research and Census, Portland State University.

What Further Research Is Needed?

The forecasting models provide an excellent basis for future work. They can be easily modified as new information becomes available.

Further research is needed on usage rates. Our estimates are based on opinions and limited observations. Better estimates would improve the accuracy of our forecasts.

The models can be enhanced so that they forecast aggregate consumption by type of material. Having forecasts for asphalt, concrete, RAP, sand and gravel, crushed rock, and other materials would be very helpful to planners, consumers, and miners.

Improvements are needed in the collection of data on income, housing, and building stock in Oregon. A substantial portion of effort in our research was used for pulling data together. DOGAMI had to develop population forecasts for the years beyond 2010. We had to create our own historical data on Oregon's housing balance. Making forecasts of housing, income, and construction activity were also part of the research effort. Ideally, there should be one consistent source for economic data on Oregon's counties.

Chapter Two
Forecast of Aggregate Consumption in Oregon

Introduction

We produced an aggregate forecast for the State of Oregon by running each of our 36 county models and then totaling the results. These totals are in Table 2.1. The forecast contains large amounts of data. For the purposes of this report, however, we are summarizing only the most important information. Readers needing more detail may wish to access the models directly.

Forecast Summary

According to our forecast, total aggregate consumption in the state will rise at a rate of 0.53% a year from 2001 to 2050. Recycling, however, will be growing at a faster rate of 1.75%. This will cut into the demand for virgin aggregate. The consumption of virgin aggregate will rise at an annual rate of just 0.44%.

Aggregate consumption for residential construction will rise modestly. This end use is very sensitive to the number of new households. Although Oregon will have many more households in the future, the rate of growth in new households will actually slow over time. This slowdown will act as a drag on aggregate demand by the residential construction sector.

Nonresidential construction will be a strong market for aggregate. It is dependent on personal income growth and the forecast for this is favorable. All else being equal, places with high income growth can support more office, warehouse, retail, and other building construction. Also, compared to housing, nonresidential structures are replaced more quickly and use more aggregate for maintenance and improvements.

There will be very little growth in the use of aggregate for roads during the forecast period. New road construction will follow the slowing growth rate in population. The demand for aggregate on logging roads will be nearly static. Increased urbanization will reduce the amount of aggregate used for maintenance per mile of road. Aggregate markets for other types of infrastructure, however, will benefit from urbanization. The more densely populated counties become, the more sewers, sidewalks, and municipal water systems they will have.

Table 2.1

Forecast of Aggregate Consumption in Oregon: Annual Averages by Decade From 2001 to 2050 (in tons)

	2001-2010	2011-2020	2021-2030	2031-2040	2041-2050
End Use:					
Residential Construction	8,017,202	8,646,643	8,952,693	9,550,114	9,918,073
Nonresidential	12,859,607	14,351,439	16,069,317	17,698,837	19,797,348
Roads	16,254,142	16,403,388	16,302,732	16,441,336	16,446,976
Other Infrastructure	8,953,933	9,809,957	10,618,100	11,481,339	12,324,539
Miscellaneous Uses	3,058,810	3,330,266	3,588,913	3,830,305	4,078,370
Total Consumption	49,143,694	52,541,693	55,531,755	59,001,931	62,565,307
Less Recycled Materials	(2,515,292)	(3,094,891)	(3,707,311)	(4,404,755)	(5,166,032)
Virgin Aggregate Use	46,628,402	49,446,802	51,824,444	54,597,176	57,399,275
Tons Per Capita	13.0	12.3	11.6	11.1	10.7

Source: DOGAMI aggregate model forecast 2001 to 2050.

Oregon's population will increase at a 1.01% rate during the forecast period. By 2050, there will be over 5.5 million residents in the state. As can be seen from the data in Table 2.2, the growth rate declines over time. In addition, the population will age. In 2000, 13.0% of all Oregonians will be over 64 years old. By 2050, this will increase to 20.1%. This is a dramatic change and it affects the state's natural growth rate by altering the balance between births and deaths.

Real personal income will grow faster than the population during the forecast period. The income growth rate, however, will be less than that of the 1970s and 1980s. At that time, personal income benefited from a large increase in the percentage of women in the workforce. This percentage is leveling out.

The number of households in Oregon will go up by 1.05% a year from 2001 to 2050. This is a little faster than the population. The difference between the two growth rates is caused by changes in the average size of households. From 1960 to 1990, the average Oregon household fell from 3.17 to 2.58 people. We expect it to fall slightly to 2.50 by 2050.

The number of manufactured and multi-family units in Oregon's housing stock will about double from 2001 to 2050. There will be 55% more single-family ("SF" in the following tables) site-built homes. The housing stock is the inventory of places where people can live in the state. The number of units that will be built will be greater than the change in the stock, because a significant number of units are built each year to replace old housing.

Oregon will add 4,510 miles of improved public roads during the fifty-year forecast period. Asphalt and oil mat road mileage will go up by 4,596. There will be 373 more miles of concrete roads. The state will lose 460 miles of gravel roads. These losses will come mostly from projects where gravel roads are resurfaced with asphalt pavement.

Table 2.2

Forecast of Population, Housing, and Road Mileage for Oregon

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	816,867	891,921	972,084	1,072,559	1,157,353	1,263,009
18 to 64 Years Old	2,104,480	2,388,227	2,564,552	2,668,143	2,904,487	3,173,271
Over 64 Years Old	436,244	493,530	678,048	921,155	1,043,056	1,117,860
Total Population	3,357,591	3,773,678	4,214,684	4,661,857	5,104,896	5,554,140
10-Year % Growth	17.9%	12.4%	11.7%	10.6%	9.5%	8.8%
Personal Inc. (Mn. 1987$)	$52,391	$62,489	$74,445	$88,281	$104,155	$122,704
10-Year % Growth	22.5%	19.3%	19.1%	18.6%	18.0%	17.8%
Housing Stock (Units):						
SF Site-Built Homes	923,815	1,018,941	1,120,718	1,221,953	1,329,772	1,437,582
SF Manufactured Homes	155,330	198,149	237,290	269,395	296,938	318,490
Multi-Family Housing	314,261	372,117	433,195	493,605	558,047	622,184
Other Housing	39,734	41,779	43,535	44,401	44,687	44,104
Less Vacant & Seasonal	(114,059)	(136,033)	(153,825)	(169,859)	(185,364)	(201,270)
Total Households	1,319,080	1,494,952	1,680,913	1,859,495	2,044,081	2,221,090
Road Mileage:						
Gravel	27,186	27,056	26,933	26,843	26,771	26,726
Asphalt and Oil Mat	36,484	37,396	38,337	39,243	40,167	41,080
Concrete	750	825	904	977	1,052	1,123
Total Road Mileage	64,419	65,277	66,173	67,063	67,990	68,929
Miles Per 100 Households	4.88	4.37	3.94	3.61	3.33	3.10

Source: DOGAMI aggregate model forecast 2001 to 2050.

Table 2.3 shows the forecast for total consumption by major sectors. From 2001 to 2050, Oregon will use 2,787.8 million tons of aggregate. Recycled materials will satisfy 6.8% of that need. The remaining 2,599.0 million tons will come from virgin aggregate sources.

Residential construction alone will consume 450.8 million tons during the period. This amount will be much greater if the state's population rises at a faster rate than forecast here.

Nonresidential construction will consume 807.8 million tons or 29.0% of the total. While nonresidential construction is a growing end use in Oregon, its share of total aggregate consumption still lags behind that of other areas of the country. This may be a reflection of lower personal incomes in Oregon compared to the country as a whole.

Roads will use 818.4 million tons of aggregate. That is 29.4% of total consumption. In recent years, we believe that roads accounted for 34% of consumption. Its share declines in the forecast because of anticipated reductions for logging roads and greater urbanization.

Other infrastructure will account for 531.9 million tons or 19.1% of total consumption. Railroads and other markets will consume 178.9 million tons.

Table 2.3

Forecast of Total Aggregate Consumption by Major End Use Sectors for the Period From 2001 to 2050

Consumption Sector	Million Tons	% of Total	Tons Per Year
Residential Construction	450.8	16.2%	9,016,945
Nonresidential	807.8	29.0%	16,155,310
Roads	818.4	29.4%	16,369,715
Other Infrastructure	531.9	19.1%	10,637,574
Railroads & Miscellaneous	178.9	6.3%	3,577,333
Total Consumption	2,787.8	100.0%	55,756,876
Less Recycled Materials	(188.9)	(6.8%)	(3,777,656)
Virgin Aggregate Use	2,599.0	93.2%	51,979,220

Source: DOGAMI aggregate model forecast 2001 to 2050.

Consumption Forecast by End Use Subcategories

Table 2.4 shows our forecast for nine subcategories of roads. Two of the subcategories include logging roads. Future aggregate consumption for logging will be about one million tons per year less than current levels. The largest reductions will occur on BLM and USFS roads. New roads will account for an average of 2.1 million tons of consumption a year. Maintenance, repair, and improvements to existing roads will continue to be the principal end use of aggregate.

Table 2.4

Forecast of Annual Average Aggregate Consumption For Roads in the Period From 2001 to 2050

End-Use Subcategory	Tons Per Year
Private Logging Roads	1,680,560
BLM, USFS, State Forest, & State Park Roads	930,321
Maintenance, Repair, & Improvement of:	
Public Gravel Roads	2,285,733
Public Asphalt & Oil Mat Roads	9,226,946
Public Concrete Roads	131,301
New Road Construction:	
Public Gravel Roads	13,222
Public Asphalt & Oil Mat Roads	1,379,432
Public Concrete Roads	299,229
Slope, Embankment, & Shoulder Work	422,971
Total	16,369,715

Source: DOGAMI aggregate model forecast 2001 to 2050.

The consumption of aggregate forecast for residential construction is shown on Table 2.5. It is divided into seven subcategories. New single-family site-built homes will use nearly half of the aggregate consumed by this sector. Significant amounts, however, will also be used for manufactured homes. While these units do not have perimeter footings or any other aggregate-intensive type of foundation work, they nonetheless do use significant amounts of aggregate.

Table 2.5

Forecast of Annual Average Aggregate Consumption For Residential Construction in the Period From 2001 to 2050

End-Use Subcategory	*Tons Per Year*
New Single-family Site-Built Homes	4,290,146
New Manufactured Home Sites	1,189,027
New Low-Rise Multi-Family Units	1,383,597
New High-Rise Multi-Family Units	199,911
New RV & Trailer Park Sites	13,339
Conversion of Existing Buildings to Multi-Family Housing	41,428
Maintenance, Improvements, & Other Residential Constr.	1,899,497
Total	9,016,945

Source: DOGAMI aggregate model forecast 2001 to 2050.

The nonresidential construction sector, shown on Table 2.6, is split into 19 subcategories. Retail stores will consume an average of 2,075,059 tons a year from 2001 to 2050. Manufacturing plants, offices, and warehouses will also be major aggregate consumers. The biggest end use, however, will occur in the "Maintenance, Improvements, and Other" subcategory. This contains miscellaneous forms of construction, but it is high because nonresidential buildings are frequently expanded and remodeled. Nonresidential buildings also use aggregate for resurfacing parking lots, repairing sidewalks, adding architectural features, and fixing private access roads.

Table 2.6

Forecast of Annual Average Aggregate Consumption For Nonresidential Construction From 2001 to 2050

End-Use Subcategory	Tons Per Year
Forest Products	186,728
Airport Buildings	109,862
Jails and Detention Centers	51,565
Hospitals and Health-Care Facilities	806,264
Hotels, Motels, and Other Lodging	259,545
Manufacturing and Laboratories	1,015,763
Municipal Buildings	97,437
High-Rise Office Buildings	277,512
Low-Rise Office Buildings	966,091
Parking Garages	152,536
Public Assembly	638,018
Retail Stores	2,075,059
Schools	536,251
Warehouses—Nonrefrigerated	1,631,968
Warehouses—Refrigerated	95,540
Power Plants & Related	176,182
Farms, Ranches, & Agricultural	901,339
Miscellaneous Buildings	271,080
Maintenance, Improvements, & Other	5,906,570
Total	16,155,310

Source: DOGAMI aggregate model forecast 2001 to 2050.

Consumption by "other infrastructure and miscellaneous uses" is shown in Table 2.7. Sewer, water, and related systems will use over 5.4 million tons a year. Bridges and dams also are significant markets.

Railroad ballast and railroad crossings will use 250,246 tons of aggregate a year. Nonconstruction uses that are not classified elsewhere total 3,327,087 tons a year. This includes uses such as jetties, golf courses, stream improvements, landscaping, filtering media for water treatment plants, and lining landfills.

Table 2.7

Forecast of Annual Average Aggregate Consumption For Other Infrastructure and Miscellaneous Uses From 2001 to 2050

End-Use Subcategory	*Tons Per Year*
Infrastructure Other Than Roads:	
Airport Runways	40,569
Bridges and Related	775,956
Dams and Reservoirs	461,264
Power Distribution	9,274
River and Marine	361,658
Sewer, Water, and Related	5,432,976
Sidewalks and Street Level Parking NEC*	153,681
Miscellaneous Non-Building Construction	699,712
Maintenance, Repair, and Other	2,702,484
Total Non-Road Infrastructure	10,637,574
Miscellaneous Uses:	
Railroad Ballast	242,360
Crossings and Other Railway Work	7,886
Uses Not Classified Elsewhere	3,327,087
Total Miscellaneous Uses	3,577,333

Source: DOGAMI aggregate model forecast 2001 to 2050.
* NEC = Not Elsewhere Classified

Sensitivity Analysis Based Upon Growth

Aggregate consumption is very sensitive to population growth. By varying the population growth rates used in the models, we can show how aggregate consumption changes. We changed the forecast for population and households in our models and then recorded the results. These are shown on Table 2.8.

We simply raised or lowered the compound annual growth rates of population and households by 0.5%, 1.0%, and 1.5%. This was done for each county. The results were then totaled for the whole state.

For example, our first test shows what happens if the population and number of households grows 1.5% faster than our original forecast. Our original forecast had the population growing by 1.01%. By adding 1.5%, it was raised to 2.51%. Under that scenario, the state's population in 2050 would hit 11.6 million. That is more than twice as much as the original forecast. Under this very high growth scenario, aggregate consumption would average 102.9 million tons per year.

If we lower the original growth rate by 1.5%, the state's population would actually decline slightly. By 2050, it would be 2.6 million. In this case, aggregate consumption averages only 32.2 million tons a year.

These forecasts are extremes. The more likely range is within 0.5% of our original forecast. Here, the population in 2050 ranges from 4.3 to 7.1 million and the number of households is between 1.7 and 2.8 million. Under these circumstances, average annual aggregate consumption goes from 45.5 to 68.3 million tons a year.

Table 2.8

Sensitivity of the Aggregate Consumption Forecast to Changes in Population and Household Growth

Change in Annual Growth Rate [31]	*Effective Population Growth Rate* [32]	*Average. Annual Consumption 2001-2050 (Tons)*	*Population In 2050*
-1.50%	-0.49%	32,161,762	2,628,695
-1.00%	+0.01%	37,026,977	3,377,329
-0.50%	+0.51%	45,463,146	4,333,749
No Change	+1.01%	55,756,876	5,554,140
+0.50%	+1.51%	68,314,022	7,109,480
+1.00%	+2.01%	83,816,555	9,089,333
+1.50%	+2.51%	102,887,710	11,606,587

Source: Analysis by DOGAMI using aggregate model forecast for 2001 to 2050.

[31] Change added to or subtracted from the annual growth rate forecasts for population and households in each county.

[32] The compound annual growth rate in Oregon's total population from 2001 to 2050.

Sensitivity Analysis Based Upon Income

Real personal income growth also affects aggregate consumption. Table 2.9 shows the results of a sensitivity analysis on real personal income.

Real personal income rises at a 1.72% annual rate in the original forecast. We varied this by 0.50% increments to see what effect it would have on the aggregate consumption forecast. The range of growth rates tried went from 0.22% to 3.22%.

At the lowest growth rate, the forecast for annual aggregate consumption averaged 48.2 million tons. This is 13.5% less than our original forecast. On the high end, with real personal income rising 3.22% a year, aggregate consumption averaged 71.1 million tons. That is 27.5% higher than our original forecast.

Table 2.9

Sensitivity of the Aggregate Consumption Forecast to Changes in the Growth Rate of Real Personal Income

Change in Annual Growth Rate[33]	*Effective Real Income Growth Rate*[34]	*Average Annual Consumption 2001-2050*	*Real Personal Income In 2050 (Mn. 1987$)*
-1.50%	+0.22%	48,209,808	$58,378
-1.00%	+0.72%	50,012,397	$74,872
-0.50%	+1.22%	52,546,127	$95,908
No Change	+1.72%	55,756,876	$122,704
+0.50%	+2.22%	59,774,380	$156,797
+1.00%	+2.72%	64,800,989	$200,123
+1.50%	+3.22%	71,094,405	$255,119

Source: Analysis by DOGAMI using aggregate model forecast for 2001 to 2050.

[33] Change added to or subtracted from the annual growth rate forecasts for real personal income in each county.

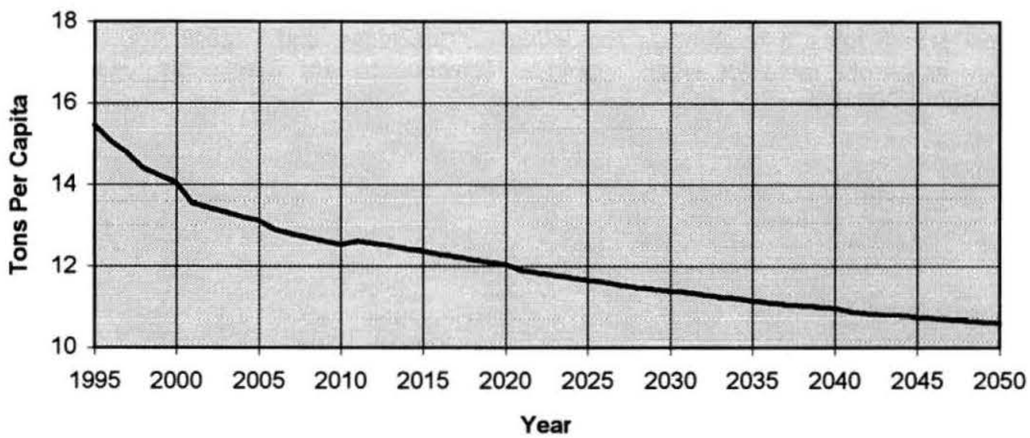
[34] The compound annual growth rate in Oregon's total real personal income from 2001 to 2050.

Forecast of Per Capita Consumption

As noted earlier, the census DOGAMI conducted on the mining industry revealed that Oregon's per capita consumption of virgin aggregate was 16.8 tons in 1993. The forecast shows this falling to 14.1 tons in the year 2000. By 2050, it will approach 10.6 tons. Increased recycling, slower annual real income and population growth, technological changes, greater urbanization, and fewer logging roads all contribute to the decline. Recycling alone accounts for 28% of the decrease. The forecast of per capita consumption of virgin aggregate is displayed in Figure 2.1.

Figure 2.1

Forecast of Per Capita Aggregate Consumption In Oregon 1995 to 2050



Source: DOGAMI aggregate model forecast 1995 to 2050.

Chapter Three
Individual County Forecasts

Introduction

The results of the county forecast are shown in this chapter. Table 3.1 is a summary of the individual county forecasts of virgin aggregate consumption. In this table, consumption is expressed in tons per year. These are annual averages for the period from 2001 to 2050.

The five largest counties ranked by their virgin aggregate consumption forecasts are Multnomah, Washington, Clackamas, Lane, and Marion. Together, these five counties will account for just over half of Oregon's total consumption of virgin aggregate in the 50-year forecast period. The top three, all of which are in the Portland metropolitan area, will consume an average of 17.9 million tons a year. That equals 34% of the state's total consumption.

Table 3.2 shows the compound annual growth rates from 2000 to 2050 for the number of households and virgin aggregate consumption for each county. The three counties with the highest growth rates in households are Jefferson, Deschutes, and Yamhill. The three ranking highest in growth rates for virgin aggregate consumption are Clackamas, Josephine, and Washington Counties.

Table 3.1

Forecast of Average Annual Virgin Aggregate Consumption By County For 2001 to 2050

County	Consumption (tons)
Baker	556,717
Benton	957,884
Clackamas	4,842,969
Clatsop	676,314
Columbia	790,655
Coos	1,120,132
Crook	511,041
Curry	590,287
Deschutes	1,951,998
Douglas	1,665,502
Gilliam	198,444
Grant	402,345
Harney	483,178
Hood River	364,963
Jackson	2,701,979
Jefferson	521,982
Josephine	971,756
Klamath	1,344,179
Lake	432,125
Lane	4,670,912
Lincoln	900,742
Linn	1,895,995
Malheur	776,220
Marion	3,491,226
Morrow	451,532
Multnomah	7,091,558
Polk	999,186
Sherman	187,146
Tillamook	549,640
Umatilla	1,146,008
Union	430,406
Wallowa	301,186
Wasco	610,029
Washington	5,951,334
Wheeler	136,845
Yamhill	1,304,805
STATE TOTAL	**51,979,220**

Source: DOGAMI county aggregate model forecasts 2001 to 2050.

Table 3.2

Forecast Growth Rates From 2000 to 2050 for Virgin Aggregate Consumption and Number of Households By County

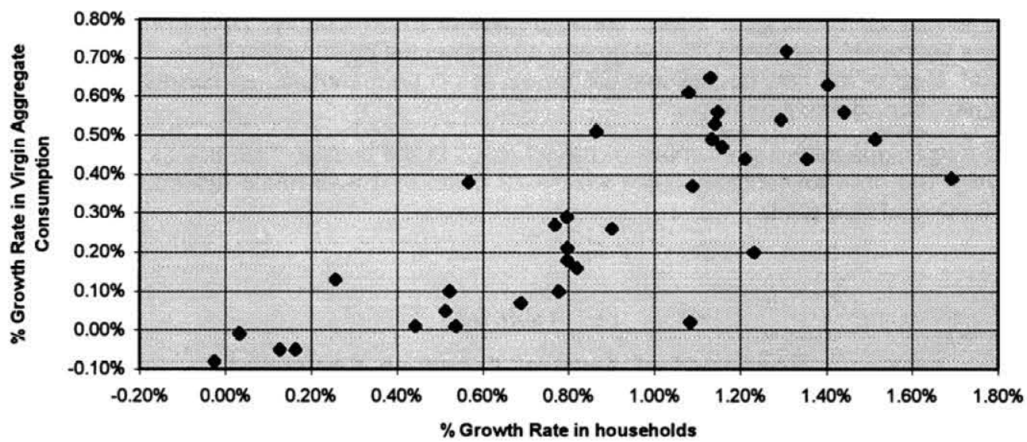
County	Growth Rate in Consumption	Growth Rate of Households
Baker	0.10%	0.78%
Benton	0.51%	0.86%
Clackamas	0.72%	1.31%
Clatsop	0.13%	0.26%
Columbia	0.47%	1.16%
Coos	0.29%	0.80%
Crook	0.20%	1.23%
Curry	0.44%	1.35%
Deschutes	0.49%	1.51%
Douglas	0.10%	0.52%
Gilliam	-0.05%	0.16%
Grant	0.01%	0.44%
Harney	-0.01%	0.03%
Hood River	0.61%	1.08%
Jackson	0.49%	1.13%
Jefferson	0.39%	1.69%
Josephine	0.65%	1.13%
Klamath	0.18%	0.80%
Lake	0.01%	0.54%
Lane	0.56%	1.15%
Lincoln	0.27%	0.77%
Linn	0.44%	1.21%
Malheur	0.16%	0.82%
Marion	0.53%	1.14%
Morrow	0.02%	1.08%
Multnomah	0.38%	0.57%
Polk	0.54%	1.29%
Sherman	-0.08%	-0.03%
Tillamook	0.21%	0.80%
Umatilla	0.26%	0.90%
Union	0.05%	0.51%
Wallowa	0.07%	0.69%
Wasco	0.37%	1.09%
Washington	0.63%	1.40%
Wheeler	-0.05%	0.13%
Yamhill	0.56%	1.44%
STATE TOTAL	0.44%	1.05%

Source: DOGAMI county aggregate model forecast 2000 to 2050.

Figure 3.1 below shows the relationship between the growth rates of virgin aggregate consumption and number of households from Table 3.2. The two growth rates are related, but the correlation is not one-to-one. That is because other factors besides household growth influence changes in virgin aggregate consumption. These include the average age of the population, the degree of personal income growth, the miles of roads in the county, the importance of logging, and changes in recycling activities.

Figure 3.1

Compound Annual Growth Rate Forecasts 2000 to 2050 For Virgin Aggregate Consumption and Number of Households By County



Source: DOGAMI county aggregate model forecast 2000 to 2050.

In the following section, there is a two-page summary for each county. Every summary begins with a discussion of the most important features of the forecast. This is followed by two tables of forecast results.

Our summaries are highly compressed versions of our county forecasts. It would be impractical to show all the details in this document. Readers interested in the complete forecasts should consider obtaining the county models.

In counties where it is significant, we report the percentage of total consumption due to logging. This can be an important figure for planners and others who are concerned about the adequacy of supply. Most of the aggregate used on logging roads is produced by logging companies for their own use. This supply does not normally enter commercial markets.

The first table in each county summary contains the aggregate forecast. Here, average annual consumption for different end uses is shown. The consumption figures are divided into the five decades of our forecast. All types of aggregate, including recycled, precast, and imported materials, are counted in end-use consumption.

The second table contains population, income, housing, and road data. The figures in this table are for single years starting with 2000 and then going out every tenth year.

Baker County

Baker County's population declined from 1960 to 1970 when it reached a low of 14,919. Since then, it has slowly recovered. Now the county is attracting large numbers of retirees. By 2005, we expect the population to finally top the level last reached in 1960. In 2005, 18% of the people living in Baker will be over 64 years old, compared to less than 13% for the whole state.

The number of households in Baker County will rise 0.78% a year from 2001 to 2050 and personal income will climb at a 1.36% rate. This growth will place a modest upward bias on local aggregate consumption. In recent years, Baker County has produced more aggregate than it has used. That is because the county is a critical supplier of high-quality railroad ballast.

Our forecast shows total aggregate consumption rising 0.15% a year. Over the 50-year period consumption will be 29.2 million tons. Around 4.7% of that will be taken up by recycled materials. Virgin aggregate consumption will grow 0.10% a year and total 27.8 million tons. That equals 556,717 tons per year.

Roads are by far the biggest market for aggregate in Baker County. They will use 63% of the county's aggregate. Another 17% will go into nonresidential construction. Housing will use 7% of the total. Most of the new houses that will be put in will be manufactured homes, which use less aggregate than site-built homes.

We forecast an increase of 47 miles of paved roads in the county. That equals about 1.5 miles for every 100 new households. There will be 29 miles of gravel roads resurfaced with asphalt and 18 miles of new roads.

Table 3.3

Forecast of Annual Average Aggregate Consumption for Baker County (in tons)

	2001-2010	2011-2020	2021-2030	2031-2040	2041-2050
End Use:					
Residential Construction	36,826	39,793	41,521	43,916	45,253
Nonresidential	90,873	95,121	100,970	106,963	115,282
Roads	372,388	371,746	366,440	364,151	359,380
Other Infrastructure	44,839	47,334	49,586	52,136	54,616
Miscellaneous Uses	23,045	23,812	24,539	25,208	25,903
Total Consumption	567,973	577,805	583,057	592,374	600,434
Less Recycled Materials	(20,774)	(24181)	(27,469)	(31,026)	(34,609)
Virgin Aggregate Use	547,199	553,625	555,588	561,348	565,825
Tons Per Capita	31.4	29.4	27.3	25.8	24.3

Table 3.4

Forecast of Population, Housing, and Road Mileage Data for Baker County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	4,181	4,413	4,631	4,932	5,193	5,548
18 to 64 Years Old	9,468	10,376	10,760	10,852	11,537	12,358
Over 64 Years Old	3,018	3,261	4,115	5,199	5,715	6,022
Total Population	16,667	18,050	19,506	20,983	22,445	23,928
10-Year % Growth	8.9%	8.3%	8.1%	7.6%	7.0%	6.6%
Personal Income (Mn. 1987$)	$210	$238	$272	$311	$358	$413
10-Year % Growth	10.9%	13.4%	14.1%	14.6%	14.9%	15.5%
Housing Stock (Units):						
SF Site-Built Homes	5,497	5,580	5,738	5,948	6,222	6,539
SF Manufactured Homes	1,578	2,190	2,767	3,270	3,711	4,065
Multi-family Housing Units	649	739	838	936	1,037	1,134
Other Housing	285	294	302	305	306	302
Less Vacant & Seasonal	(1,366)	(1,547)	(1,729)	(1,915)	(2,093)	(2,257)
Total Households	6,644	7,257	7,916	8,543	9,182	9,782
Road Mileage:						
Gravel	649	642	636	630	625	620
Asphalt and Oil Mat	586	595	603	611	618	625
Concrete	23	24	26	28	30	31
Total Road Mileage	1,258	1,261	1,265	1,269	1,273	1,276
Road Miles Per 100 Households	18.93	17.38	15.98	14.85	13.86	13.05

Benton County

The number of households in Benton County will climb 0.86% per year between 2001 and 2050. To accommodate this growth, there will be a net increase of 18,222 units to the housing stock. Benton County's households are clustered in an urban area around Oregon State University. The county has a high population density relative to the rest of the state. As a result, much of the new housing will be multi-family.

Benton is the fourth smallest county in Oregon. It has the fewest miles of road per person for counties with a population between 50,000 and 100,000. Consequently, our forecast shows that only 28% of Benton County's aggregate will be used for roads.

The county will add 71 miles of roads. Logging and forestry roads are important end-use markets and will account for 6% of the county's total aggregate consumption.

From 2001 to 2050, Benton County will consume 50.7 million tons of aggregate, of which 2.8 million tons will come from recycling. Virgin aggregate consumption will total 47.9 million tons or 957,884 tons a year. It will rise at a 0.51% annual rate during the forecast period.

Residential construction will account for 17% of the county's aggregate consumption. Nonresidential construction will use 28% of the total. Infrastructure, other than roads, will use 19%.

Table 3.5

Forecast of Annual Average Aggregate Consumption for Benton County (in tons)

	2001-2010	*2011-2020*	*2021-2030*	*2031-2040*	*2041-2050*
End Use:					
Residential Construction	144,990	171,913	178,214	191,692	199,942
Nonresidential	190,799	249,238	285,004	317,734	362,570
Roads	274,886	290,658	286,728	288,563	286,797
Other Infrastructure	157,925	180,169	194,812	211,143	227,000
Miscellaneous Uses	63,435	72,239	77,424	82,261	87,230
Total Consumption	832,035	964,217	1,022,182	1,091,392	1,163,540
Less Recycled Materials	(35,647)	(47,103)	(56,207)	(66,716)	(78,274)
Virgin Aggregate Use	796,388	917,114	965,976	1,024,677	1,085,266
Tons Per Capita	9.5	10.0	9.6	9.3	9.1

Table 3.6

Forecast of Population, Housing, and Road Mileage Data for Benton County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	16,656	16,488	17,775	19,626	20,934	22,637
18 to 64 Years Old	57,413	61,278	65,084	67,200	72,543	78,674
Over 64 Years Old	7,755	9,097	12,922	18,000	20,312	21,565
Total Population	81,824	86,863	95,781	104,826	113,789	122,876
10-Year % Growth	14.9%	6.2%	10.3%	9.4%	8.6%	8.0%
Personal Income (Mn. 1987$)	$1,200	$1,363	$1,615	$1,909	$2,248	$2,646
10-Year % Growth	19.7%	13.6%	18.5%	18.2%	17.8%	17.7%
Housing Stock (Units):						
SF Site-Built Homes	19,545	20,731	22,366	24,003	25,783	27,572
SF Manufactured Homes	2,523	3,089	3,689	4,171	4,585	4,904
Multi-family Housing Units	9,612	10,806	12,405	13,999	15,730	17,469
Other Housing	1,187	1,186	1,208	1,203	1,185	1,142
Less Vacant & Seasonal	(1,773)	(2,234)	(2,450)	(2,723)	(2,978)	(3,258)
Total Households	31,094	33,578	37,218	40,653	44,305	47,830
Road Mileage:						
Gravel	631	629	625	623	621	620
Asphalt and Oil Mat	648	660	676	691	707	722
Concrete	18	20	21	23	25	27
Total Road Mileage	1,298	1,309	1,323	1,337	1,353	1,369
Road Miles Per 100 Households	4.17	3.90	3.55	3.29	3.05	2.86

Clackamas County

Clackamas is Oregon's third most populous county. It has a densely populated urban area near Portland, highly productive farms to the south, and extensive forests to the east.

Clackamas County is well situated for growth because of its extensive interstate highway system, proximity to Portland, rail connections, and educated work force. This favorable location explains why Clackamas added more warehouse space per person between 1978 and 1993 than any other western Oregon county. The county also ranked high in per capita retail store construction.

Clackamas County's weakness, however, has been in manufacturing. The neighboring counties of Multnomah and Washington attracted a disproportionate share of the region's manufacturing construction since 1978.

Interstate Highway 205 gives aggregate producers in Washington's Clark County easy access to Clackamas. Clackamas County imports large amounts of aggregate.

Our forecast calls for a 1.31% growth rate in the number of households in Clackamas County. Personal income will rise by 1.97% per year. The county will increase its housing stock by 125,903 units. Residential construction will take up 20% of the aggregate consumed during the forecast period.

Because of its high growth rate, Clackamas County will add 590 miles of roads. The majority of these will be residential streets. About 18% of the aggregate consumed from 2001 to 2050 will go into roads.

According to our forecast, Clackamas County will need 261.8 million tons of aggregate, including 19.6 million tons of recycled materials. Virgin aggregate use will total 242.1 million tons or 4,842,969 tons a year. Consumption will grow 0.72% per year. That is the highest growth rate in the forecast.

Table 3.7

Forecast of Annual Average Aggregate Consumption for Clackamas County (in tons)

	2001-2010	2011-2020	2021-2030	2031-2040	2041-2050
End Use:					
Residential Construction	947,293	1,010,484	1,053,723	1,128,978	1,177,854
Nonresidential	1,429,438	1,638,154	1,857,574	2,065,363	2,329,746
Roads	914,405	918,000	915,281	939,627	955,917
Other Infrastructure	785,678	891,778	993,491	1,099,320	1,202,361
Miscellaneous Uses	313,975	351,024	386,343	419,362	453,256
Total Consumption	4,390,790	4,809,441	5,206,412	5,652,651	6,119,134
Less Recycled Materials	(245,913)	(311,672)	(383,023)	(465,438)	(557,535)
Virgin Aggregate Use	4,144,877	4,497,769	4,823,388	5,187,213	5,561,599
Tons Per Capita	11.2	10.5	9.9	9.5	9.2

Table 3.8

Forecast of Population, Housing, and Road Mileage Data for Clackamas County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	85,500	95,397	106,725	120,196	131,907	145,976
18 to 64 Years Old	215,489	249,394	275,550	293,298	325,173	360,734
Over 64 Years Old	38,462	50,347	71,527	99,791	115,140	125,268
Total Population	339,451	395,138	453,802	513,285	572,220	631,978
10-Year % Growth	21.4%	16.4%	14.8%	13.1%	11.5%	10.4%
Personal Income (Mn. 1987$)	$6,103	$7,582	$9,319	$11,309	$13,563	$16,158
10-Year % Growth	26.6%	24.2%	22.9%	21.4%	19.9%	19.1%
Housing Stock (Units):						
SF Site-Built Homes	96,173	111,334	126,815	142,080	157,963	173,590
SF Manufactured Homes	12,398	16,100	19,231	21,749	23,880	25,531
Multi-family Housing Units	25,943	32,245	38,862	45,537	52,636	59,747
Other Housing	2,611	2,979	3,330	3,635	3,920	4,159
Less Vacant & Seasonal	(8,945)	(11,365)	(13,051)	(14,591)	(16,152)	(17,718)
Total Households	128,180	151,292	175,186	198,411	222,247	245,310
Road Mileage:						
Gravel	800	799	799	801	804	807
Asphalt and Oil Mat	2,935	3,044	3,154	3,264	3,377	3,492
Concrete	36	41	47	52	57	62
Total Road Mileage	3,771	3,884	4,000	4,117	4,238	4,361
Road Miles Per 100 Households	2.94	2.57	2.28	2.07	1.91	1.78

Clatsop County

The 1993 survey of mining found that 48% of the aggregate produced in Clatsop County was used in forestry. Over 99% of the timber logged in Clatsop County comes from either private or state lands. Both use large amounts of crushed and pit run rock on their roads. The county's wet climate and steep terrain contribute to this high consumption rate on their roads. Our forecast assumes smaller timber harvests. Over the entire forecast period, forestry will account for 33% of total aggregate consumption.

The population forecast shows a decline for several years followed by modest growth. From 2001 to 2050 the number of households will go up by 1,820. Population will rise at a rate of 0.17% per year. All of that growth will occur in the over-64 age group. The share of the population over 64 will be 17% in the year 2000. By 2050, it will reach 26%.

Even though the residential population will grow slowly, we forecast an increase of 3,875 units in the housing stock. About half of these new units will be vacation homes. Multi-family units will make up 31% of the construction. That is a fairly high percentage for a small, mostly rural county. It reflects the high percentage of retirees and a preference to live near the coast where land is expensive.

Clatsop County will add only 21 miles of improved roads. Because of its extensive number of logging roads, 55% of the county's aggregate consumption will be used for roads. Housing will be 9% of the total, and nonresidential construction will take up 16%.

Aggregate consumption from 2001 to 2050 will total 35.5 million tons. Of that, 1.7 million will come from recycling. Virgin aggregate consumption will grow 0.13% a year and equal 33.8 million tons for the period. That is the equivalent of 676,314 tons per year.

Table 3.9

Forecast of Annual Average Aggregate Consumption for Clatsop County (in tons)

	2001-2010	2011-2020	2021-2030	2031-2040	2041-2050
End Use:					
Residential Construction	19,249	85,259	72,689	73,988	74,411
Nonresidential	89,223	110,064	116,388	121,964	130,102
Roads	377,641	396,593	389,157	388,088	385,232
Other Infrastructure	109,404	115,520	117,698	120,794	123,700
Miscellaneous Uses	25,419	26,273	26,684	27,053	27,441
Total Consumption	620,938	733,709	722,616	731,887	740,885
Less Recycled Materials	(22,702)	(30,687)	(34,041)	(38,332)	(42,705)
Virgin Aggregate Use	598,235	703,022	688,575	693,555	698,181
Tons Per Capita	18.8	22.1	20.9	20.4	20.0

Table 3.10

Forecast of Population, Housing, and Road Mileage Data for Clatsop County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	7,859	6,882	6,905	7,076	7,170	7,400
18 to 64 Years Old	19,213	18,602	18,426	17,832	18,262	18,904
Over 64 Years Old	5,431	5,844	7,009	8,460	8,953	9,113
Total Population	32,503	31,328	32,340	33,368	34,385	35,417
10-Year % Growth	-3.0%	-3.6%	3.2%	3.2%	3.0%	3.0%
Personal Income (Mn. 1987$)	$497	$511	$566	$627	$697	$777
10-Year % Growth	2.1%	2.9%	10.6%	10.9%	11.1%	11.4%
Housing Stock (Units):						
SF Site-Built Homes	12,316	11,776	12,600	12,954	13,302	13,637
SF Manufactured Homes	1,185	1,141	1,772	2,130	2,417	2,636
Multi-family Housing Units	3,747	3,500	4,120	4,428	4,708	4,956
Other Housing	467	434	420	403	384	361
Less Vacant & Seasonal	(4,407)	(3,648)	(5,177)	(5,719)	(6,114)	(6,462)
Total Households	13,309	13,202	13,735	14,196	14,696	15,129
Road Mileage:						
Gravel	609	610	610	609	609	609
Asphalt and Oil Mat	550	550	557	561	565	568
Concrete	19	19	20	20	21	22
Total Road Mileage	1,178	1,179	1,186	1,191	1,195	1,199
Road Miles Per 100 Households	8.85	8.93	8.64	8.39	8.13	7.93

Columbia County

Columbia County will experience significant growth because of its proximity to Portland. From 2001 to 2050, the number of households will increase 1.16% per year. In addition, the county will see large gains in the 0–17 and 18–64 age groups. Large increases in working-age families are favorable for aggregate markets.

Columbia County will put in place 22,390 housing units. After subtracting losses, the total housing stock will go up by 13,603. Over 61% of the new units put in place will be site-built single-family homes. Manufactured homes will be 21% of the total.

Because of a sharp rise in school-aged children, the pace of new school construction will be 60% higher than in the 1978–1993 period.

In 1990, 32% of the households in Columbia County lived in rural areas.[34] That is a high percentage of rural households, considering the county's relatively high population density. Future growth, however, will be concentrated around towns, and by 2050 only 24% of the households will live in rural areas.

Columbia County will add 60 miles of new roads and pave 22 miles of existing gravel roads. In total, roads will absorb 42% of the county's aggregate consumption. Forest roads alone are 16% of the total.

Total aggregate consumption from 2001 to 2050 will be 41.5 million tons. Recycling will equal 2.0 million tons. Virgin aggregate consumption will rise 0.47% per year. It will equal 39.5 million tons during the forecast period and average 790,655 tons a year.

Table 3.11

Forecast of Annual Average Aggregate Consumption for Columbia County (in tons)

	2001-2010	*2011-2020*	*2021-2030*	*2031-2040*	*2041-2050*
End Use:					
Residential Construction	115,078	123,892	128,517	136,808	142,417
Nonresidential	126,899	145,487	167,198	188,270	216,742
Roads	355,897	354,443	349,650	348,385	345,364
Other Infrastructure	102,244	114,938	127,446	140,735	154,127
Miscellaneous Uses	45,960	49,767	53,476	56,934	60,491
Total Consumption	746,077	788,528	826,287	871,131	919,140
Less Recycled Materials	(27,299)	(33,014)	(38,941)	(45,640)	(52,995)
Virgin Aggregate Use	718,778	755,514	787,347	825,491	866,145
Tons Per Capita	15.4	14.3	13.3	12.6	12.0

[34] A rural area is defined as a census block where the population density is less than 165 people per square mile or approximately one household per ten acres. A census block is usually a small area of land designated by the U.S. Census. In an urban area, a census block is typically equal to a city block. The percentage of households living in rural areas was calculated for this report by Mr. Richard Crucchiola of the State Service Center for GIS.

Table 3.12

Forecast of Population, Housing, and Road Mileage Data for Columbia County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	11,829	13,176	14,476	16,028	17,408	19,090
18 to 64 Years Old	26,571	30,363	32,969	34,601	37,943	41,704
Over 64 Years Old	4,944	5,924	8,371	11,629	13,288	14,317
Total Population	43,344	49,463	55,816	62,258	68,639	75,111
10-Year % Growth	15.0%	14.1%	12.8%	11.5%	10.2%	9.4%
Personal Income (Mn. 1987$)	$628	$760	$913	$1,090	$1,292	$1,527
10-Year % Growth	22.1%	21.0%	20.2%	19.4%	18.5%	18.2%
Housing Stock (Units):						
SF Site-Built Homes	11,983	13,548	15,242	16,964	18,801	20,665
SF Manufactured Homes	2,699	3,407	4,038	4,557	5,005	5,360
Multi-family Housing Units	1,790	2,176	2,591	3,010	3,455	3,904
Other Housing	743	800	847	876	892	889
Less Vacant & Seasonal	(1,021)	(1,284)	(1,476)	(1,652)	(1,830)	(2,033)
Total Households	16,194	18,646	21,242	23,755	26,323	28,786
Road Mileage:						
Gravel	365	358	353	348	345	342
Asphalt and Oil Mat	543	560	577	593	608	622
Concrete	3	4	5	5	6	6
Total Road Mileage	911	922	934	946	958	971
Road Miles Per 100 Households	5.63	4.95	4.40	3.98	3.64	3.37

Coos County

Coos County's economy has struggled because of job losses in the fishing and forest products industries. Population and income growth have been depressed, although recently there have been signs of a turnaround. Our forecast shows a modest improvement for the county.

Coos County has large private stands of juvenile timber. Much of this will mature in 20 to 30 years and help stimulate future construction of manufacturing space. Still, the county is disadvantaged by its lack of natural gas, poor highway connections, and an inadequate railroad. If these limitations are tackled, Coos County could grow more substantially than predicted here.

Single-family housing dominates the region and will continue to do so in the future. By 2050, only 17% of the occupied units will be multi-family. The number of households will increase 0.80% per year during the forecast period. Personal income growth will rise at a 1.43% rate.

Roads will take up 40% of the aggregate consumed in Coos County. Half of this will go towards BLM, USFS, and private logging roads. During the forecast period, Coos County will add 82 miles of paved roads. About 11 miles of that will come from the resurfacing of gravel roads with asphalt.

The relatively small share of aggregate used for public roads is due, in part, to the way the population is distributed. The county's population is highly concentrated. Most reside in or near the city of Coos Bay. Only 20% of the households in Coos County live in rural areas.

Overall, 58.8 million tons of aggregate will be used from 2001 to 2050. Recycled aggregate will total 2.8 million tons. Virgin aggregate consumption will be 56.0 million tons or 1,120,132 tons a year. It will grow at a modest rate of 0.29% per year.

Table 3.13

Forecast of Annual Average Aggregate Consumption for Coos County (in tons)

	2001-2010	2011-2020	2021-2030	2031-2040	2041-2050
End Use:					
Residential Construction	153,431	158,919	165,762	176,528	183,044
Nonresidential	190,939	208,583	230,633	251,069	279,092
Roads	473,239	469,851	467,120	468,036	465,831
Other Infrastructure	218,133	231,629	245,543	260,496	275,148
Miscellaneous Uses	54,813	58,097	61,517	64,701	67,975
Total Consumption	1,090,555	1,127,079	1,170,575	1,220,829	1,271,090
Less Recycled Materials	(39,889)	(47,182)	(55,161)	(63,956)	(73,280)
Virgin Aggregate Use	1,050,666	1,079,897	1,115,414	1,156,874	1,197,811
Tons Per Capita	14.7	14.0	13.4	12.9	12.5

Table 3.14

Forecast of Population, Housing, and Road Mileage Data for Coos County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	15,392	15,999	16,818	17,990	18,938	20,247
18 to 64 Years Old	40,144	44,134	45,802	46,249	49,197	52,726
Over 64 Years Old	12,459	13,913	17,467	21,974	24,148	25,463
Total Population	67,995	74,046	80,087	86,213	92,283	98,436
10-Year % Growth	13.1%	8.9%	8.2%	7.6%	7.0%	6.7%
Personal Income (Mn. 1987$)	$911	$1,052	$1,212	$1,396	$1,607	$1,852
10-Year % Growth	17.0%	15.5%	15.2%	15.2%	15.1%	15.2%
Housing Stock (Units):						
SF Site-Built Homes	19,903	21,332	22,845	24,450	26,234	28,080
SF Manufactured Homes	4,232	5,442	6,475	7,349	8,114	8,728
Multi-family Housing Units	3,815	4,432	5,050	5,671	6,329	6,982
Other Housing	2,925	2,955	2,923	2,831	2,699	2,510
Less Vacant & Seasonal	(2,709)	(3,080)	(3,415)	(3,772)	(4,104)	(4,434)
Total Households	28,166	31,081	33,877	36,530	39,273	41,867
Road Mileage:						
Gravel	1,115	1,112	1,109	1,107	1,105	1,104
Asphalt and Oil Mat	956	972	988	1,002	1,017	1,032
Concrete	17	18	20	21	22	24
Total Road Mileage	2,088	2,102	2,116	2,130	2,145	2,159
Road Miles Per 100 Households	7.41	6.76	6.25	5.83	5.46	5.16

Crook County

Crook County experienced strong growth in the 1970s, which was followed by a pronounced slowdown in the 1980s. Now, the county is growing again, and its outlook is favorable. Our forecast shows the number of households rising 1.23% a year from 2001 to 2050. That is well above the 1.05% statewide average.

We expect the housing stock to grow by 6,486 units. Single-family homes, both site-built and manufactured, will dominate Crook County's housing market. By 2050, 87% of the housing will be single family. That is only slightly less than what it is today.

Crook County's population will remain fairly young compared to neighboring counties. Much of the growth we expect will be in the prime income-earning age group of 18- to 64-year-olds. To accommodate this, there will be large amounts of nonresidential construction for schools, public assembly buildings, and businesses.

Crook County is large and has a widely dispersed population. Because of this, the county uses most of its aggregate for roads. Forestry accounts for 3% of that. The rest goes on public roads. Between 2001 and 2050, the county will add 46 miles of paved roads, with 14 miles of that coming from resurfacing existing gravel roads.

Total aggregate consumption over the 50-year forecast period will be 26.8 million tons. Virgin aggregate use will be 25.6 million tons or 511,041 tons per year. It will grow at a 0.20% rate. This growth rate is low relative to the rise in population. That is because roads make up a large proportion of the county's current aggregate consumption. This sector is less sensitive to population growth than most other end uses.

Table 3.15

Forecast of Annual Average Aggregate Consumption for Crook County (in tons)

	2001-2010	*2011-2020*	*2021-2030*	*2031-2040*	*2041-2050*
End Use:					
Residential Construction	45,234	51,886	54,555	58,252	60,640
Nonresidential	106,956	113,575	122,493	131,815	144,999
Roads	284,028	286,542	281,438	278,443	274,328
Other Infrastructure	50,187	54,421	58,275	62,397	66,629
Miscellaneous Uses	15,627	17,445	19,151	20,746	22,385
Total Consumption	502,031	523,870	535,912	551,653	568,980
Less Recycled Materials	(18,366)	(21,927)	(25,251)	(28,897)	(32,801)
Virgin Aggregate Use	483,666	501,943	510,661	522,756	536,180
Tons Per Capita	25.8	23.4	21.0	19.2	17.8

Table 3.16

Forecast of Population, Housing, and Road Mileage Data for Crook County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	4,638	5,431	6,035	6,729	7,365	8,132
18 to 64 Years Old	10,054	11,658	12,802	13,547	14,973	16,569
Over 64 Years Old	2,569	2,843	3,938	5,381	6,174	6,707
Total Population	17,261	19,932	22,775	25,657	28,512	31,408
10-Year % Growth	22.4%	15.5%	14.3%	12.7%	11.1%	10.2%
Personal Income (Mn. 1987$)	$225	$269	$322	$384	$457	$545
10-Year % Growth	26.1%	19.4%	19.6%	19.3%	19.0%	19.4%
Housing Stock (Units):						
SF Site-Built Homes	4,524	4,853	5,311	5,831	6,437	7,101
SF Manufactured Homes	1,978	2,692	3,414	4,044	4,601	5,054
Multi-family Housing Units	537	657	800	945	1,098	1,250
Other Housing	366	397	431	457	477	487
Less Vacant & Seasonal	(795)	(1,004)	(1,190)	(1,365)	(1,536)	(1,699)
Total Households	6,610	7,594	8,766	9,913	11,076	12,192
Road Mileage:						
Gravel	429	426	423	420	417	415
Asphalt and Oil Mat	479	488	498	507	516	524
Concrete	0	0	0	1	1	1
Total Road Mileage	908	914	921	927	933	940
Road Miles Per 100 Households	13.73	12.03	10.50	9.35	8.43	7.71

Curry County

In the last 35 years, Curry County has had periods of declining population interspersed with short-lived inward migrations. The current upswing began in 1987 and is due mostly to retirees moving into the county. In 1970, only 10% of the population was over 64 years old. By 1990, it was 26%. Our forecast shows that number heading even higher.

Because of the population's age, construction will be skewed toward residential buildings and related infrastructure, such as sewers, water, and light-duty streets. There will be a bias away from types of construction that are favored in places with younger populations. These include schools, offices, and factories.

The number of households in Curry County will increase by 10,584 from 2001 to 2050. That is a growth rate of 1.35% per year. The stock of housing will climb by 12,087. Housing will rise faster than the number of households because of the growing demand for vacation and recreational units. In the model we also assume a normal level of vacancies. About one in five units constructed in Curry County between 2001 and 2050 will be multi-family.

With most of it citizens living close together along the coast, Curry County has relatively few miles of roads compared to its land area. New households, however, will stimulate demand for new residential streets. Our forecast shows the county adding 51 miles of improved roads.

Curry County will consume 31.0 million tons of aggregate during the forecast interval and 15% of this will be forest related. The county will get 4.8% of its aggregate from recycled materials. Virgin aggregate consumption will total 29.5 million tons or 590,287 a year. It will grow at a rate of 0.44% per year.

Table 3.17

Forecast of Annual Average Aggregate Consumption for Curry County (in tons)

	2001-2010	2011-2020	2021-2030	2031-2040	2041-2050
End Use:					
Residential Construction	90,409	99,170	105,564	113,187	119,149
Nonresidential	96,200	108,156	123,438	137,903	156,473
Roads	258,613	256,847	253,973	254,454	254,876
Other Infrastructure	83,925	94,131	104,558	115,229	126,069
Miscellaneous Uses	23,745	26,599	29,492	32,191	34,964
Total Consumption	552,891	584,902	617,025	652,964	691,531
Less Recycled Materials	(20,226)	(24,489)	(29,080)	(34,211)	(39,873)
Virgin Aggregate Use	532,666	560,413	587,945	618,753	651658
Tons Per Capita	18.8	16.9	15.5	14.5	13.7

Table 3.18

Forecast of Population, Housing, and Road Mileage Data for Curry County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	5,006	5,888	6,587	7,397	8,135	9,041
18 to 64 Years Old	13,944	16,177	17,866	18,938	21,044	23,445
Over 64 Years Old	6,816	8,405	10,784	13,738	15,682	17,231
Total Population	25,766	30,470	35,237	40,073	44,861	49,717
10-Year % Growth	32.8%	18.3%	15.6%	13.7%	11.9%	10.8%
Personal Income (Mn. 1987$)	$355	$448	$553	$674	$810	$965
10-Year % Growth	35.2%	26.1%	23.6%	21.8%	20.2%	19.2%
Housing Stock (Units):						
SF Site-Built Homes	6,835	7,817	8,980	10,266	11,684	13,187
SF Manufactured Homes	3,310	4,277	5,149	5,897	6,543	7,074
Multi-family Housing Units	1,300	1,649	2,035	2,443	2,876	3,322
Other Housing	1,347	1,432	1,480	1,473	1,412	1,296
Less Vacant & Seasonal	(1,763)	(2,116)	(2,424)	(2,716)	(3,002)	(3,267)
Total Households	11,028	13,059	15,221	17,362	19,514	21,612
Road Mileage:						
Gravel	369	368	366	365	365	364
Asphalt and Oil Mat	496	507	518	529	541	552
Concrete	1	1	2	2	2	3
Total Road Mileage	867	876	886	897	908	918
Road Miles Per 100 Households	7.86	6.71	5.82	5.17	4.65	4.25

Deschutes County

Deschutes is a high-growth county that has been attracting both young families and retirees. In 1970, 11% of the population was over 64. By 1990, the percentage rose to only 13%. Because many of its new residents are wage earners, the county has enjoyed strong personal income growth. All this has contributed to a healthy market for aggregates.

Our forecast shows the number of households growing 1.51% a year from 2001 to 2050. With much of the increase coming from working families, there will be considerable construction activity for retail, office, manufacturing, and warehouse space.

Deschutes County will add 52,786 units to its housing stock. Vacation homes will be a significant part of this total. One out of every five tons of aggregate that will be used in the county will go directly into housing.

Demand for new roads will be strong. The county will add 253 miles of roads and resurface 20 miles of gravel roads with asphalt. Roads will account for 30% of the aggregate consumed from 2001 to 2050. Just 1% will go into logging roads.

Total aggregate consumption will be 102.5 million tons. Recycled materials will contribute 4.9 million tons. Virgin aggregate use will be 97.6 million tons and rise at a 0.49% rate during the forecast. An average of 1,951,998 tons of virgin aggregate will be used each year in Deschutes County.

Table 3.19

Forecast of Annual Average Aggregate Consumption for Deschutes County (in tons)

	2001-2010	2011-2020	2021-2030	2031-2040	2041-2050
End Use:					
Residential Construction	344,083	380,098	399,920	429,106	448,851
Nonresidential	422,566	490,442	569,741	646,640	746,119
Roads	609,958	620,864	619,657	627,641	628,651
Other Infrastructure	239,836	277,410	313,808	352,085	390,206
Miscellaneous Uses	110,743	125,307	139,387	152,556	166,073
Total Consumption	1,727,186	1,894,122	2,042,513	2,208,029	2,379,901
Less Recycled Materials	(63,206)	(79,327)	(96,282)	(115,705)	(137,242)
Virgin Aggregate Use	1,663,980	1,814,795	1,946,231	2,092,325	2,242,660
Tons Per Capita	14.0	12.8	11.8	11.1	10.6

Table 3.20

Forecast of Population, Housing, and Road Mileage Data for Deschutes County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	26,099	31,301	35,966	41,323	46,072	51,647
18 to 64 Years Old	66,887	80,773	91,666	99,570	112,151	126,028
Over 64 Years Old	13,685	16,794	24,404	34,633	40,576	44,724
Total Population	106,671	128,868	152,036	175,526	198,799	222,399
10-Year % Growth	41.1%	20.8%	18.0%	15.5%	13.3%	11.9%
Personal Income (Mn. 1987$)	$1,700	$2,195	$2,780	$3,459	$4,239	$5,153
10-Year % Growth	46.0%	29.2%	26.6%	24.4%	22.6%	21.5%
Housing Stock (Units):						
SF Site-Built Homes	33,762	39,415	45,799	52,390	59,418	66,529
SF Manufactured Homes	9,779	12,645	15,194	17,262	18,998	20,336
Multi-family Housing Units	5,486	6,998	8,688	10,421	12,263	14,118
Other Housing	1,299	1,502	1,702	1,869	2,016	2,129
Less Vacant & Seasonal	(8,269)	(9,632)	(10,795)	(11,891)	(12,974)	(13,982)
Total Households	42,057	50,928	60,587	70,051	79,721	89,130
Road Mileage:						
Gravel	580	573	567	563	561	560
Asphalt and Oil Mat	1,400	1,457	1,514	1,567	1,620	1,671
Concrete	1	1	1	2	2	2
Total Road Mileage	1,981	2,030	2,082	2,132	2,183	2,234
Road Miles Per 100 Households	4.71	3.99	3.44	3.04	2.74	2.51

Douglas County

Douglas County will grow during the forecast period, but only at a moderate pace. Between 2001 and 2050, the number of households will increase 0.52% per year for a total gain of 11,730. The over-64 age group will constitute over half of the county's population growth.

With a timber-dependent industrial base, personal income in Douglas County has been lagging behind the rest of Oregon. This weakness will persist. Personal income will grow only 1.12% a year.

Nearly 48% of the housing units put in place during the forecast period will be site-built single-family homes. Manufactured homes, which are popular in Douglas County, will take up 34% of the total. Overall, residential construction will use 11% of the county's aggregate in our forecast.

Douglas has more roads than any other county in Oregon. The county will add 65 miles of new roads from 2001 to 2050. Roads will use 48% of the county's expected aggregate consumption. Much of this will be for logging roads.

Logging will account for 25% of the county's aggregate consumption. Private logging, BLM, and USFS roads will account for nearly half of all the aggregate that will be used on roads in Douglas County.

We expect Douglas County to use 89.9 million tons of aggregate during the forecast period. Recycled materials, at 6.6 million tons, will make up a significant share of this total. Virgin aggregate demand will grow at a 0.10% rate. Over the fifty years, 83.3 million tons of virgin aggregate will be consumed. That equals 1,665,502 tons a year.

Table 3.21

Forecast of Annual Average Aggregate Consumption for Douglas County (in tons)

	2001-2010	2011-2020	2021-2030	2031-2040	2041-2050
End Use:					
Residential Construction	189,799	192,494	195,548	204,921	208,232
Nonresidential	310,433	327,985	355,974	382,980	421,769
Roads	871,227	863,577	854,176	850,378	842,191
Other Infrastructure	277,983	287,820	298,089	309,984	321,936
Miscellaneous Uses	78,302	80,733	83,449	85,958	88,555
Total Consumption	1,727,743	1,752,608	1,787,235	1,834,221	1,882,682
Less Recycled Materials	(101,528)	(115,328)	(130,148)	(146,444)	(163,531)
Virgin Aggregate Use	1,626,215	1,637,280	1,657,087	1,687,776	1,719,151
Tons Per Capita	15.5	14.9	14.4	14.0	13.6

Table 3.22

Forecast of Population, Housing, and Road Mileage Data for Douglas County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	25,069	25,703	26,215	27,225	28,013	29,315
18 to 64 Years Old	59,211	62,496	62,977	61,920	64,343	67,494
Over 64 Years Old	17,177	18,745	23,067	28,505	30,635	31,599
Total Population	101,457	106,944	112,259	117,650	122,991	128,408
10-Year % Growth	7.1%	5.4%	5.0%	4.8%	4.5%	4.4%
Personal Income (Mn. 1987$)	$1,312	$1,449	$1,607	$1,796	$2,021	$2,291
10-Year % Growth	9.2%	10.4%	10.9%	11.8%	12.5%	13.4%
Housing Stock (Units):						
SF Site-Built Homes	26,827	27,918	29,028	30,196	31,555	32,968
SF Manufactured Homes	9,060	10,554	11,788	12,787	13,645	14,275
Multi-family Housing Units	4,720	5,197	5,640	6,056	6,491	6,898
Other Housing	1,788	1,781	1,758	1,712	1,656	1,580
Less Vacant & Seasonal	(2,933)	(3,480)	(3,762)	(4,036)	(4,280)	(4,529)
Total Households	39,463	41,970	44,452	46,715	49,068	51,193
Road Mileage:						
Gravel	3,163	3,160	3,156	3,153	3,151	3,149
Asphalt and Oil Mat	2,172	2,188	2,203	2,218	2,232	2,246
Concrete	28	30	31	32	34	35
Total Road Mileage	5,363	5,377	5,390	5,403	5,417	5,430
Road Miles Per 100 Households	13.59	12.81	12.13	11.57	11.04	10.61

Gilliam County

Gilliam County's population fell between the years 1960 and 1990, but it was an uneven decline. The number of people under 65 years of age fell by 50%, while the number of those older than 64 actually increased 29%.

The forecast shows the population falling until 2010. After that, it rises slowly. For the period 2001 to 2050, there will be an increase of 54 households in Gilliam County. An additional 50 housing units for vacation and other seasonal uses will be added. Two manufactured homes will be put in place in the county for every new site-built home. Overall, only 1% of the aggregate will be used for residential construction. The largest identified end use other than roads will be farms and ranches.

With its weak growth rate, Gilliam County will add only two miles of paved roads. With over 80 miles of roads per 100 households, road maintenance and improvements will be the largest market for aggregate in the county. Roads will make up 65% of the county's consumption. Less than 0.1% of this will go on logging roads.

Total aggregate consumption will be 10.4 million tons in the period from 2001 to 2050. Virgin aggregate consumption will equal 9.9 million tons. It will decline at an annual rate of 0.05% and average 198,444 tons a year.

Table 3.23

Forecast of Annual Average Aggregate Consumption for Gilliam County (in tons)

	2001-2010	2011-2020	2021-2030	2031-2040	2041-2050
End Use:					
Residential Construction	2,258	1,515	2,716	2,935	2,839
Nonresidential	49,990	49,804	49,467	49,202	49,123
Roads	133,150	136,378	136,330	136,311	134,404
Other Infrastructure	13,145	13,222	13,269	13,343	13,359
Miscellaneous Uses	7,815	7,764	7,706	7,649	7,591
Total Consumption	206,358	208,683	209,489	209,439	207,316
Less Recycled Materials	(7,548)	(8,733)	(9,868)	(10,968)	(11,948)
Virgin Aggregate Use	198,811	199,950	199,621	198,471	195,368
Tons Per Capita	123.0	124.4	121.9	119.0	115.1

Table 3.24

Forecast of Population, Housing, and Road Mileage Data for Gilliam County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	426	398	390	390	390	400
18 to 64 Years Old	884	843	823	783	793	813
Over 64 Years Old	340	350	408	478	498	498
Total Population	1,650	1,591	1,621	1,651	1,681	1,711
10-Year % Growth	-5.7%	-3.6%	1.9%	1.9%	1.8%	1.8%
Personal Income (Mn. 1987$)	$23	$23	$24	$26	$29	$32
10-Year % Growth	-6.8%	-0.1%	6.9%	8.2%	9.6%	11.0%
Housing Stock (Units):						
SF Site-Built Homes	722	659	615	600	591	584
SF Manufactured Homes	114	137	143	182	221	248
Multi-family Housing Units	29	27	25	26	28	29
Other Housing	22	20	19	19	18	17
Less Vacant & Seasonal	(249)	(222)	(162)	(166)	(176)	(186)
Total Households	637	621	641	661	681	691
Road Mileage:						
Gravel	311	312	311	311	310	310
Asphalt and Oil Mat	249	248	249	249	250	251
Concrete	0	0	0	0	0	0
Total Road Mileage	560	560	560	560	560	560
Road Miles Per 100 Households	87.88	90.16	87.36	84.74	82.28	81.11

Grant County

Grant County's population dropped in the 1960s, but has been growing slowly since 1970. The age of the population is also going up. The number of 0- to 17-year olds fell by 301, while the total population rose by 904 from 1970 to 1990.

Our forecast shows modest growth continuing, although half of the population increase will occur in the over-64 age group. The number of households will rise by 0.44% a year. From 2001 to 2050, there will be 808 new households in Grant County.

Besides new households, demand for vacation and recreational houses will stimulate some residential construction. About one out of every 12 homes in Grant County is occupied seasonally. Many of the new units will be manufactured homes. The housing stock in 2050 will have 984 more manufactured homes than in the year 2000. That compares to increases of only 120 site-built homes and 103 multi-family units.

Grant County will add 10 more miles of paved roads and 5 miles of new roads between the years 2000 and 2050. The county has a fairly extensive road system and will use 73% of its aggregate to maintain, repair, and improve it. About 4% of its aggregate will be used for roads by logging companies, the BLM, and USFS.

Total aggregate consumption will be 21.1 million tons. After subtracting a million tons for recycling, we forecast virgin aggregate consumption at 20.1 million tons. That is an average of 402,345 tons a year. Consumption will rise at a 0.01% rate from 2001 to 2050.

Table 3.25

Forecast of Annual Average Aggregate Consumption for Grant County (in tons)

	2001-2010	2011-2020	2021-2030	2031-2040	2041-2050
End Use:					
Residential Construction	14,522	16,535	17,100	17,965	18,303
Nonresidential	63,372	63,187	64,278	65,524	67,876
Roads	305,354	310,418	308,419	308,334	306,570
Other Infrastructure	24,775	25,645	26,359	27,212	28,061
Miscellaneous Uses	5,932	6,119	6,310	6,494	6,682
Total Consumption	413,956	421,904	422,467	425,529	427,491
Less Recycled Materials	(15,141)	(17,655)	(19,901)	(22,286)	(24,639)
Virgin Aggregate Use	398,815	404,248	402,565	403,243	402,852
Tons Per Capita	47.3	45.9	43.7	42.0	40.3

Table 3.26

Forecast of Population, Housing, and Road Mileage Data for Grant County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	2,188	2,361	2,398	2,473	2,537	2,647
18 to 64 Years Old	4,799	4,955	4,975	4,874	5,050	5,276
Over 64 Years Old	1,229	1,287	1,617	2,033	2,183	2,243
Total Population	8,216	8,603	8,990	9,380	9,770	10,166
10-Year % Growth	4.0%	4.7%	4.5%	4.3%	4.2%	4.1%
Personal Income (Mn. 1987$)	$109	$120	$132	$147	$163	$184
10-Year % Growth	8.4%	9.5%	10.2%	10.9%	11.6%	12.7%
Housing Stock (Units):						
SF Site-Built Homes	2,399	2,363	2,370	2,397	2,449	2,519
SF Manufactured Homes	1,067	1,283	1,518	1,723	1,906	2,051
Multi-family Housing Units	224	240	262	284	306	327
Other Housing	235	222	211	197	182	163
Less Vacant & Seasonal	(653)	(720)	(782)	(853)	(919)	(980)
Total Households	3,272	3,388	3,578	3,748	3,924	4,080
Road Mileage:						
Gravel	654	653	652	651	650	649
Asphalt and Oil Mat	622	624	626	629	631	632
Concrete	0	0	0	0	0	0
Total Road Mileage	1,276	1,277	1,279	1,280	1,281	1,281
Road Miles Per 100 Households	39.01	37.71	35.74	34.16	32.66	31.40

Harney County

Harney County is suffering from a weak economy due to losses in timber-related jobs. In 1990, 30% of the county's residents were under 18 years old. That was one of the highest percentages in Oregon, yet Harney County's economy is not producing enough jobs to keep young families within its borders. Our forecast shows population losses persisting for several years, followed by a slow improvement. Overall, the population will decrease at a 0.05% rate from 2001 to 2050.

The number of people over 64 in Harney County will go up by 532. This will be offset by a drop of 709 people under 65 years of age. Because of this, there will be more small households headed by seniors. Consequently, there will be an increase of 46 households from 2001 to 2050. There will be a modest amount of new housing also. Nearly 80% of it will be manufactured housing.

Harney is the largest and most sparsely populated county in Oregon. Yet, 62% of its residents live in just two adjacent communities. Sixty-five percent of the households lived in census blocks with more than one home per ten acres. This is a surprising concentration of residents for such a county. There were 9 other counties whose residents were more spread out than Harney County's. That helps explain why the county ranks only 17th out of 36 in total road mileage.

While Harney has fewer than 1,300 miles of improved roads, the lack of activity in other markets leaves roads as the main end use for aggregate. Roads will account for 76% of Harney County's total aggregate consumption. Logging roads will be a very small part of this.

The second biggest end use is agriculture. In the model, agricultural uses, such as private gravel roads on ranches, are grouped in with nonresidential construction. That is why the nonresidential category represents 17% of the consumption forecast.

Total aggregate consumption will be 25.4 million tons between 2001 and 2050. Virgin aggregate use will be 24.2 million tons. It will fall at a 0.01% rate per year. Harney County's average annual consumption of virgin aggregate will be 483,178 tons.

Table 3.27

Forecast of Annual Average Aggregate Consumption for Harney County (in tons)

	2001-2010	*2011-2020*	*2021-2030*	*2031-2040*	*2041-2050*
End Use:					
Residential Construction	5,034	9,711	9,710	10,212	10,155
Nonresidential	85,314	86,705	86,969	87,428	88,504
Roads	381,687	386,811	384,436	385,663	383,535
Other Infrastructure	22,119	22,354	22,505	22,842	23,172
Miscellaneous Uses	4,171	4,097	4,101	4,104	4,107
Total Consumption	498,326	509,677	507,721	510,249	509,473
Less Recycled Materials	(18,227)	(21,326)	(23,917)	(26,722)	(29,363)
Virgin Aggregate Use	480,099	488,351	483,804	483,527	480,110
Tons Per Capita	75.1	78.5	76.8	76.0	74.6

Table 3.28

Forecast of Population, Housing, and Road Mileage Data for Harney County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	1,723	1,502	1,472	1,473	1,463	1,483
18 to 64 Years Old	3,866	3,607	3,507	3,327	3,347	3,397
Over 64 Years Old	1,053	1,076	1,276	1,525	1,585	1,585
Total Population	6,642	6,185	6,255	6,325	6,395	6,465
10-Year % Growth	-6.5%	-6.9%	1.1%	1.1%	1.1%	1.1%
Personal Income (Mn. 1987$)	$87	$84	$89	$95	$103	$114
10-Year % Growth	-5.8%	-3.6%	6.0%	7.3%	8.7%	10.1%
Housing Stock (Units):						
SF Site-Built Homes	2,051	1,925	1,846	1,780	1,734	1,703
SF Manufactured Homes	744	750	919	1,060	1,188	1,285
Multi-family Housing Units	263	248	259	269	279	287
Other Housing	189	165	154	140	127	113
Less Vacant & Seasonal	(465)	(439)	(469)	(502)	(532)	(560)
Total Households	2,781	2,648	2,708	2,747	2,797	2,827
Road Mileage:						
Gravel	895	897	896	896	896	896
Asphalt and Oil Mat	515	514	515	515	516	517
Concrete	0	0	0	0	0	0
Total Road Mileage	1,410	1,411	1,411	1,412	1,412	1,413
Road Miles Per 100 Households	50.72	53.27	52.11	51.39	50.49	49.98

Hood River County

Hood River County experienced strong growth in the 1970s, but that decade was sandwiched in between two slow-growth decades. Now the county is enjoying a resurgence. Currently, Hood River County gets a significant proportion of its aggregate from mines in Washington State.

The number of households living in Hood River County will grow at a rate of 1.08% during the period 2001 to 2050. The age distribution of the population will follow the typical pattern for the state. The share of older residents will rise. However, the county will see large gains in the number of children and people between 18 and 64 years old. This will stimulate construction in a broad range of projects from schools and factories to retailers and health offices.

With 5,208 new households and good demand for seasonal housing, residential construction in Hood River County will account for 15% of total aggregate consumption. Twenty percent of the new housing units put in place will be multi-family.

We expect that roads will account for 36% of the county's aggregate consumption. About 4% will be timber related. Most of that will go to USFS roads. The county will also need aggregate for 27 miles of new public roads. Overall, Hood River County will see very little change in its use of aggregate for roads. It is the second smallest county in Oregon, and its population is highly concentrated in the narrow Hood River Valley. Consequently, there are relatively few roads.

Between 2001 and 2050, total aggregate consumption in Hood River County will be 19.2 million tons. After subtracting 0.9 million tons of recycled materials, we get a forecast of 18.2 million tons of virgin aggregate consumption. That equals 364,963 tons per year. This will grow at an annual rate of 0.61%.

Table 3.29

Forecast of Annual Average Aggregate Consumption for Hood River County (in tons)

	2001-2010	2011-2020	2021-2030	2031-2040	2041-2050
End Use:					
Residential Construction	48,172	54,369	56,488	60,300	62,671
Nonresidential	79,656	90,194	102,207	114,186	130,292
Roads	135,114	137,603	137,090	138,162	138,345
Other Infrastructure	51,447	57,032	62,370	68,104	73,965
Miscellaneous Uses	20,692	22,300	23,800	25,197	26,635
Total Consumption	335,081	361,497	381,955	405,950	431,909
Less Recycled Materials	(12,266)	(15,136)	(18,002)	(21,270)	(24,904)
Virgin Aggregate Use	322,816	346,361	363,953	384,680	407,005
Tons Per Capita	15.8	15.1	14.2	13.6	13.2

Table 3.30

Forecast of Population, Housing, and Road Mileage Data for Hood River County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	5,061	5,629	6,143	6,770	7,317	7,993
18 to 64 Years Old	11,652	13,392	14,440	15,071	16,452	18,012
Over 64 Years Old	2,433	2,559	3,597	4,977	5,662	6,076
Total Population	19,146	21,580	24,180	26,818	29,431	32,081
10-Year % Growth	14.0%	12.7%	12.0%	10.9%	9.7%	9.0%
Personal Income (Mn. 1987$)	$266	$315	$373	$442	$524	$623
10-Year % Growth	16.8%	18.2%	18.6%	18.5%	18.4%	18.8%
Housing Stock (Units):						
SF Site-Built Homes	5,639	6,128	6,744	7,385	8,085	8,803
SF Manufactured Homes	1,089	1,467	1,841	2,154	2,427	2,642
Multi-family Housing Units	1,055	1,254	1,492	1,732	1,986	2,239
Other Housing	378	409	441	466	487	501
Less Vacant & Seasonal	(831)	(956)	(1,130)	(1,301)	(1,474)	(1,646)
Total Households	7,331	8,302	9,388	10,435	11,510	12,539
Road Mileage:						
Gravel	118	117	115	114	114	113
Asphalt and Oil Mat	506	512	519	525	531	538
Concrete	1	1	1	1	2	2
Total Road Mileage	625	630	635	641	646	652
Road Miles Per 100 Households	8.52	7.58	6.77	6.14	5.62	5.20

Jackson County

Jackson County experienced strong growth for most of the past 35 years. This pattern will continue. Our forecast shows the number of households increasing by 51,474. The population will grow at a rate of 1.13% a year. The biggest gains will occur in the prime income earning group of 18- to 64-year-olds. All this will contribute to a strong and diversified market for aggregates.

Residential construction will consume 17% of the aggregate used in the county between 2001 and 2050. The housing stock will go up by 55,628 units to satisfy the needs of new households and the normal level of vacancies. Seasonal and recreational homes are only a minor part of the total picture in Jackson County. Multi-family housing will make up 27% of the new units put in place during the forecast period.

The county will add 246 miles of new roads. Private logging, BLM, and USFS roads will use an average of 123,715 tons a year in our forecast. That equals 4% of total consumption. Road work of all types will account for 26% of the county's aggregate consumption.

Total aggregate consumption for the 2001 to 2050 period will be 145.2 million tons. Recycling is significant in Jackson County and will satisfy 7.0% of the market. Virgin aggregate consumption will rise 0.49% annually and average 2,701,979 tons a year. For the whole period, it will be 135.1 million tons.

Table 3.31

Forecast of Annual Average Aggregate Consumption for Jackson County (in tons)

	2001-2010	2011-2020	2021-2030	2031-2040	2041-2050
End Use:					
Residential Construction	437,276	478,270	497,303	530,700	554,075
Nonresidential	572,125	645,518	731,676	816,764	928,822
Roads	755,550	767,437	763,333	769,951	770,484
Other Infrastructure	639,440	682,536	722,647	765,127	806,579
Miscellaneous Uses	147,616	162,956	177,665	191,407	205,519
Total Consumption	2,552,007	2,736,717	2,892,623	3,073,949	3,265,479
Less Recycled Materials	(130,120)	(163,617)	(198,294)	(237,693)	(281,155)
Virgin Aggregate Use	2,421,887	2,573,101	2,694,329	2,836,256	2,984,323
Tons Per Capita	13.2	12.4	11.6	11.0	10.6

Table 3.32

Forecast of Population, Housing, and Road Mileage Data for Jackson County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	40,476	45,465	49,879	55,268	59,939	65,706
18 to 64 Years Old	102,499	117,899	127,755	133,810	146,606	161,107
Over 64 Years Old	26,848	29,982	40,393	53,975	61,304	66,179
Total Population	169,823	193,346	218,027	243,053	267,849	292,992
10-Year % Growth	16.0%	13.9%	12.8%	11.5%	10.2%	9.4%
Personal Income (Mn. 1987$)	$2,476	$3,012	$3,642	$4,368	$5,197	$6,160
10-Year % Growth	21.4%	21.6%	20.9%	19.9%	19.0%	18.5%
Housing Stock (Units):						
SF Site-Built Homes	46,905	52,411	58,549	64,792	71,475	78,273
SF Manufactured Homes	10,935	13,669	16,113	18,095	19,781	21,102
Multi-family Housing Units	11,615	14,007	16,630	19,265	22,061	24,880
Other Housing	2,858	3,094	3,321	3,488	3,617	3,687
Less Vacant & Seasonal	(4,336)	(5,462)	(6,242)	(6,948)	(7,667)	(8,490)
Total Households	67,978	77,719	88,371	98,692	109,268	119,452
Road Mileage:						
Gravel	1,570	1,564	1,560	1,557	1,556	1,555
Asphalt and Oil Mat	1,687	1,731	1,776	1,820	1,864	1,908
Concrete	64	72	80	88	96	103
Total Road Mileage	3,321	3,367	3,416	3,465	3,515	3,567
Road Miles Per 100 Households	4.89	4.33	3.87	3.51	3.22	2.99

Jefferson County

Except for a brief period in the mid-1980s, Jefferson County's population has grown steadily since 1960. Our forecast shows this continuing. The number of households will more than double to 14,590 by 2050.

Part of the county's growth will be a spillover effect from neighboring Deschutes County. Another important factor is Jefferson County's high natural growth. Unlike much of the state, Jefferson County will see the number of residents under 18 rising faster than the number of those over 64 years old.

While population growth is skewed towards younger people, personal income in Jefferson County depends largely on agriculture. When farm prices are strong, personal income goes up sharply. Such periods are usually short-lived. In general, per capita income will lag significantly behind the rest of the state. This will put a drag on income-sensitive types of construction such as offices and retailers.

With its rising population, Jefferson County will see the number of units in its housing stock rise by 118%. Vacation, recreational, and other seasonal housing represent almost a fifth of the current housing stock. Such housing will remain important in the future. Multi-family housing has an unusually large share of the market in this rural county. Since Jefferson County has many young, low-income families, about 19% of the housing put in place during the forecast period will be multi-family.

With its spread-out population and high growth rate, Jefferson County will use 46% of its aggregate for roads. Around 3% will be timber related. The county will add 59 miles of new roads and pave over 29 miles of existing gravel roads.

The county will use 27.4 million tons of aggregate between 2001 and 2050. It will recycle 1.3 million tons and consume 26.1 million tons of virgin aggregate. During the period, virgin aggregate consumption will rise by 0.39% per year. It will average 521,982 tons a year.

Table 3.33

Forecast of Annual Average Aggregate Consumption for Jefferson County (in tons)

	2001-2010	*2011-2020*	*2021-2030*	*2031-2040*	*2041-2050*
End Use:					
Residential Construction	59,089	69,686	74,808	80,796	85,246
Nonresidential	113,658	124,828	137,943	151,634	170,108
Roads	257,830	259,831	250,247	243,638	236,543
Other Infrastructure	43,238	49,902	55,650	61,618	67,691
Miscellaneous Uses	23,399	26,552	29,413	32,087	34,834
Total Consumption	497,215	530,798	548,061	569,773	594,422
Less Recycled Materials	(18,194)	(22,218)	(25,826)	(29,849)	(34,271)
Virgin Aggregate Use	479,021	508,580	522,236	539,925	560,151
Tons Per Capita	23.2	20.2	17.4	15.5	14.2

Table 3.34

Forecast of Population, Housing, and Road Mileage Data for Jefferson County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	6,015	7,614	8,947	10,364	11,732	13,296
18 to 64 Years Old	10,027	12,421	14,447	15,945	18,212	20,680
Over 64 Years Old	2,247	2,583	3,948	5,823	6,933	7,713
Total Population	18,289	22,618	27,342	32,132	36,877	41,689
10-Year % Growth	33.5%	23.7%	20.9%	17.5%	14.8%	13.0%
Personal Income (Mn. 1987$)	$223	$288	$368	$461	$569	$698
10-Year % Growth	37.0%	29.5%	27.7%	25.2%	23.4%	22.6%
Housing Stock (Units):						
SF Site-Built Homes	4,140	4,817	5,712	6,715	7,835	9,032
SF Manufactured Homes	2,310	3,088	3,871	4,558	5,158	5,645
Multi-family Housing Units	881	1,140	1,463	1,813	2,191	2,581
Other Housing	976	1,047	1,104	1,095	1,020	875
Less Vacant & Seasonal	(2,000)	(2,383)	(2,700)	(2,996)	(3,282)	(3,543)
Total Households	6,307	7,709	9,451	11,185	12,921	14,590
Road Mileage:						
Gravel	337	331	323	317	312	308
Asphalt and Oil Mat	556	575	596	614	630	644
Concrete	0	0	1	1	1	1
Total Road Mileage	894	906	920	932	943	953
Road Miles Per 100 Households	14.17	11.75	9.73	8.33	7.30	6.53

Josephine County

Between 1960 and 1981, the population of Josephine County doubled. After that, a weakening economy and reductions in forestry jobs caused a marked slowdown. The economy has since turned around, and Josephine County is growing again.

Our forecast shows this growth extending into the future. The population will rise at an annual rate of 1.11%. From 2001 to 2050, there will be 21,631 more households in Josephine County. Many of these will consist of retirees. One out of four people living in the county by 2050 will be over 64 years old. Income levels in Josephine County have lagged well behind those of the state. This will improve slightly in the future.

In 1990, Josephine County had a population density of 38 people per square mile. That is 30% higher than the average for Oregon. Even with that higher density, 30% of the county's population lived in rural areas. This pronounced bias towards rural living is reflected in the choice of housing. According to our forecast, only 14% of the units put in place will be multi-family. The rest is split between site-built and manufactured homes for single families. Vacation and seasonal housing, which make up less than 2% of the county's housing stock, are minor factors in the forecast.

The county will need to add 102 miles of new roads in order to accommodate its growth. Roads will use 30% of the aggregate consumed in the forecast period. Private logging and publicly owned forest roads will use 5% of the total.

Aggregate consumption will total 52.0 million tons between the years 2001 and 2050. Recycled materials, at 3.5 million tons, are an important part of that. Virgin aggregate consumption will grow 0.65% per year and equal 48.6 million tons. Consumption, on an annual basis, will equal 971,756 tons.

Table 3.35

Forecast of Annual Average Aggregate Consumption for Josephine County (in tons)

	2001-2010	2011-2020	2021-2030	2031-2040	2041-2050
End Use:					
Residential Construction	185,929	214,723	223,311	236,837	245,999
Nonresidential	172,568	198,340	232,916	265,269	308,114
Roads	302,741	314,417	314,427	317,020	317,105
Other Infrastructure	156,432	176,458	194,833	213,741	232,257
Miscellaneous Uses	63,297	70,030	76,404	82,359	88,473
Total Consumption	880,966	973,969	1,041,891	1,115,226	1,191,948
Less Recycled Materials	(41,011)	(54,334)	(67,709)	(82,746)	(99,420)
Virgin Aggregate Use	839,955	919,635	974,181	1,032,480	1,092,528
Tons Per Capita	10.8	10.4	9.9	9.4	9.1

Table 3.36

Forecast of Population, Housing, and Road Mileage Data for Josephine County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	16,983	19,785	21,720	24,030	26,099	28,648
18 to 64 Years Old	41,318	47,864	51,918	54,381	59,649	65,632
Over 64 Years Old	13,801	14,551	19,249	25,312	28,711	31,065
Total Population	72,102	82,200	92,887	103,723	114,459	125,345
10-Year % Growth	14.8%	14.0%	13.0%	11.7%	10.4%	9.5%
Personal Income (Mn. 1987$)	$921	$1,113	$1,339	$1,600	$1,896	$2,241
10-Year % Growth	18.7%	20.9%	20.3%	19.4%	18.5%	18.2%
Housing Stock (Units):						
SF Site-Built Homes	20,583	22,733	25,489	28,361	31,458	34,642
SF Manufactured Homes	6,496	7,935	9,386	10,591	11,624	12,445
Multi-family Housing Units	2,781	3,238	3,799	4,366	4,962	5,561
Other Housing	1,005	1,111	1,236	1,349	1,458	1,553
Less Vacant & Seasonal	(2,188)	(2,544)	(2,883)	(3,205)	(3,529)	(3,893)
Total Households	28,678	32,474	37,027	41,462	45,973	50,309
Road Mileage:						
Gravel	713	710	708	707	705	705
Asphalt and Oil Mat	964	983	1,004	1,025	1,046	1,067
Concrete	12	13	15	17	18	20
Total Road Mileage	1,689	1,707	1,727	1,748	1,770	1,791
Road Miles Per 100 Households	5.89	5.26	4.66	4.22	3.85	3.56

Klamath County

As with much of Oregon, Klamath County grew strongly in the 1970s. This was followed by a period of protracted weakness. Per capita income in the past was comparable to the state's average, but in the mid-1980s the county fell behind. Klamath was particularly hard hit by losses in timber industry jobs.

The county's population growth rate is recovering. We expect there will be 12,213 new households in Klamath County between 2001 and 2050. This equals an annual growth rate of 0.80%.

Even though Klamath County had a low population density in 1990 of 10 people per square mile, 76% of its residents lived in towns and cities. Because of this relatively high concentration, we expect that multi-family units will make up 20% of all the units put in place during the forecast period.

Klamath is Oregon's fourth largest county and ranks sixth in improved-roads mileage. Roads will account for 52% of the county's future aggregate consumption. They will add 64 miles of new roads and pave over 25 miles of existing gravel roads. Private logging, BLM, USFS, and State Forestry Department roads will use 6% of the county's aggregate.

Total aggregate consumption will be 70.6 million tons. The county will use 67.2 million tons of virgin aggregate from 2001 to 2050. This equals an average of 1,344,179 tons a year. Virgin aggregate consumption will grow at an annual rate of 0.18%.

Table 3.37

Forecast of Annual Average Aggregate Consumption for Klamath County (in tons)

	2001-2010	*2011-2020*	*2021-2030*	*2031-2040*	*2041-2050*
End Use:					
Residential Construction	124,027	134,077	139,461	148,427	153,650
Nonresidential	253,516	267,660	289,046	310,545	341,672
Roads	739,787	736,385	727,558	726,372	720,506
Other Infrastructure	143,805	153,094	161,978	171,897	181,781
Miscellaneous Uses	80,088	83,123	86,122	88,898	91,765
Total Consumption	1,341,224	1,374,340	1,404,165	1,446,139	1,489,375
Less Recycled Materials	(49,059)	(57,521)	(66,160)	(75,751)	(85,858)
Virgin Aggregate Use	1,291,165	1,316,819	1,338,005	1,370,388	1,403,516
Tons Per Capita	19.4	18.2	17.1	16.3	15.6

Table 3.38

Forecast of Population, Housing, and Road Mileage Data for Klamath County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	15,733	16,822	17,744	19,020	20,072	21,484
18 to 64 Years Old	38,492	42,521	44,307	44,922	47,885	51,377
Over 64 Years Old	9,213	9,715	12,789	16,761	18,555	19,541
Total Population	63,438	69,058	74,840	80,703	86,512	92,402
10-Year % Growth	9.8%	8.9%	8.4%	7.8%	7.2%	6.8%
Personal Income (Mn. 1987$)	$790	$890	$1,010	$1,155	$1,329	$1,542
10-Year % Growth	11.8%	12.6%	13.5%	14.3%	15.0%	16.1%
Housing Stock (Units):						
SF Site-Built Homes	17,815	18,427	19,252	20,206	21,366	22,653
SF Manufactured Homes	6,077	7,676	9,194	10,503	11,662	12,587
Multi-family Housing Units	3,596	4,059	4,566	5,071	5,602	6,122
Other Housing	925	903	868	808	732	633
Less Vacant & Seasonal	(3,315)	(3,583)	(3,841)	(4,134)	(4,407)	(4,682)
Total Households	25,099	27,483	30,040	32,453	34,955	37,312
Road Mileage:						
Gravel	1,101	1,095	1,089	1,084	1,079	1,076
Asphalt and Oil Mat	1,470	1,488	1,506	1,524	1,541	1,558
Concrete	5	5	5	6	6	7
Total Road Mileage	2,576	2,588	2,600	2,613	2,627	2,640
Road Miles Per 100 Households	10.26	9.42	8.66	8.05	7.51	7.08

Lake County

Lake County has had an irregular growth pattern. Its population declined in the 1960s and 1980s. There was a large increase in the 1970s. Our forecast calls for fairly slow growth of 0.50% a year. This will be the result of a modest out-migration that will offset some of the natural growth in the county.

From 2001 to 2050, the number of households will go up by 905. Fully 46% of the population increase expected in our forecast will come from the group over 64 years old. This is reflected in our income forecast. Lake County ranked 24th in the state in per capita income. By 2050, its ranking will drop to 29th.

Lake is Oregon's third largest county, and its residents are scattered over a wide area. Because of the long distances between residents, Lake has more roads per person than all but three other counties. With so much mileage and only modest growth, we expect road work to dominate the aggregate market. Our forecast shows the county using 74% of its aggregate on roads. Timber and BLM roads will be 6% of the total.

The wide population distribution affects housing. Only 9% of the housing put in place from 2001 to 2050 will be multi-family. Manufactured homes, which are especially economical in remote areas, will be 66% of the total. One unit out of every six added to the county's housing stock will be a seasonal-use home.

Nearly half of the aggregate consumed for nonresidential uses will go to farms, ranches, and other agricultural businesses.

Total aggregate consumption will be 22.7 million tons during the 2001 to 2050 period. Recycling will amount to 1.1 million tons. That leaves 21.6 million tons of virgin aggregate consumption. Virgin aggregate consumption will grow at only a 0.01% rate and average 432,125 tons a year.

Table 3.39

Forecast of Annual Average Aggregate Consumption for Lake County (in tons)

	2001-2010	2011-2020	2021-2030	2031-2040	2041-2050
End Use:					
Residential Construction	13,282	14,971	15,466	16,373	16,720
Nonresidential	66,026	66,709	68,858	71,249	74,781
Roads	336,381	338,527	336,340	336,358	334,422
Other Infrastructure	24,230	24,959	25,647	26,517	27,434
Miscellaneous Uses	6,038	6,266	6,483	6,691	6,898
Total Consumption	445,958	451,432	452,794	457,188	460,255
Less Recycled Materials	(16,310)	(18,890)	(21,331)	(23,944)	(26,528)
Virgin Aggregate Use	429,648	432,542	431,464	433,244	433,728
Tons Per Capita	55.4	52.9	50.1	48.0	45.8

Table 3.40

Forecast of Population, Housing, and Road Mileage Data for Lake County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	2,025	2,127	2,177	2,266	2,338	2,452
18 to 64 Years Old	4,343	4,609	4,668	4,607	4,807	5,057
Over 64 Years Old	1,165	1,205	1,522	1,924	2,082	2,152
Total Population	7,533	7,941	8,367	8,797	9,227	9,661
10-Year % Growth	4.6%	5.4%	5.4%	5.1%	4.9%	4.7%
Personal Income (Mn. 1987$)	$98	$107	$118	$131	$147	$167
10-Year % Growth	4.0%	9.0%	10.3%	11.4%	12.4%	13.6%
Housing Stock (Units):						
SF Site-Built Homes	2,139	2,083	2,060	2,056	2,078	2,121
SF Manufactured Homes	928	1,158	1,405	1,623	1,822	1,982
Multi-family Housing Units	188	202	220	237	256	273
Other Housing	235	235	238	237	235	231
Less Vacant & Seasonal	(541)	(565)	(609)	(660)	(707)	(753)
Total Households	2,949	3,113	3,313	3,494	3,684	3,854
Road Mileage:						
Gravel	921	920	919	919	918	917
Asphalt and Oil Mat	715	717	719	720	722	724
Concrete	0	0	0	0	0	0
Total Road Mileage	1,636	1,637	1,638	1,639	1,640	1,641
Road Miles Per 100 Households	55.49	52.59	49.44	46.91	44.52	42.59

Lane County

Lane County has enjoyed good population growth, except for a brief period in the 1980s. With an infrastructure supportive of economic growth, the county has the capacity to attract and keep jobs. Because of this, 70% of the population growth we forecast for the period from 2001 to 2050 will be in the under-65 age group. Income growth will also be strong. This will create a large need for aggregate for a wide variety of construction projects.

The county's housing stock will rise by 110,752 units. Vacation and seasonal homes will be less than 1% of the total. By 2050, 90% of the county's residents will live in areas with densities greater than one family per 10 acres. That is a high level of urbanization for Oregon and explains why 34% of the new housing units put in place will be multi-family. Some of them will be high-rise residential buildings.

Lane has more miles of improved roads than all other counties but one. Lane County will add 473 miles to accommodate its expected growth. Over 40% of the public roads in Lane County are forest related and are maintained by the BLM, USFS, State Park system, and State Forestry Department. These, combined with private forest roads, will use 7% of the county's aggregate during the forecast period.

Total aggregate consumption in Lane County will be 251.1 million tons from 2001 to 2050. Recycling is a growing factor. Over 17.5 million tons of recycled materials will be used. Virgin aggregate consumption will be 233.5 million tons or 4,670,912 tons per year. It will rise at an annual rate of 0.56%.

Table 3.41

Forecast of Annual Average Aggregate Consumption for Lane County (in tons)

	2001-2010	2011-2020	2021-2030	2031-2040	2041-2050
End Use:					
Residential Construction	876,638	921,320	953,601	1,022,514	1,068,739
Nonresidential	1,143,525	1,281,812	1,446,874	1,600,727	1,809,311
Roads	1,155,831	1,155,901	1,152,131	1,167,514	1,172,887
Other Infrastructure	869,586	969,852	1,069,406	1,176,877	1,284,695
Miscellaneous Uses	304,659	333,905	362,468	389,142	416,543
Total Consumption	4,350,238	4,662,791	4,984,480	5,356,774	5,752,176
Less Recycled Materials	(221,807)	(278,807)	(341,732)	(414,250)	(495,302)
Virgin Aggregate Use	4,128,432	4,383,984	4,642,748	4,942,523	5,256,873
Tons Per Capita	11.6	10.9	10.3	9.9	9.6

Table 3.42

Forecast of Population, Housing, and Road Mileage Data for Lane County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	73,710	80,464	88,489	98,724	107,004	117,265
18 to 64 Years Old	215,074	248,343	269,458	282,871	309,979	340,591
Over 64 Years Old	42,069	48,534	67,584	92,801	105,826	114,045
Total Population	330,853	377,341	425,531	474,396	522,809	571,901
10-Year % Growth	16.7%	14.1%	12.8%	11.5%	10.2%	9.4%
Personal Income (Mn. 1987$)	$4,735	$5,732	$6,899	$8,253	$9,813	$11,646
10-Year % Growth	20.5%	21.1%	20.4%	19.6%	18.9%	18.7%
Housing Stock (Units):						
SF Site-Built Homes	91,105	101,811	112,796	123,830	135,753	147,877
SF Manufactured Homes	17,988	23,337	27,821	31,430	34,533	36,969
Multi-family Housing Units	30,072	36,664	43,387	50,079	57,267	64,530
Other Housing	3,453	3,711	3,900	3,998	4,039	3,994
Less Vacant & Seasonal	(9,377)	(11,693)	(13,262)	(14,679)	(16,140)	(17,797)
Total Households	133,241	153,830	174,642	194,658	215,452	235,573
Road Mileage:						
Gravel	2,184	2,182	2,181	2,181	2,182	2,185
Asphalt and Oil Mat	3,027	3,115	3,201	3,286	3,374	3,463
Concrete	61	68	76	83	90	97
Total Road Mileage	5,272	5,365	5,458	5,550	5,647	5,745
Road Miles Per 100 Households	3.96	3.49	3.13	2.85	2.62	2.44

Lincoln County

Lincoln County's population grew 58% from 1960 to 1990. This growth was interrupted only a few times because of job losses in fishing and forest products. Lincoln County is now the 12th most densely populated county in the state.

The county's population will increase at a rate of 0.74% per year from 2001 to 2050. The proportion of people over 64 years of age will jump to 26% in 2050. In 1990 it was 20%. Lincoln County will add 8,488 households in the forecast period. The housing stock, however, will rise by 11,794 because of a large increase in vacation homes.

In 1990, 77% of the population lived in towns, cities, and suburbs. By 2050, it will be 81%. Many of the residents live near the coast, where land prices will be less affordable than elsewhere in the county. That is why we expect that multi-family units will make up 23% of the housing additions.

Lincoln County will add 50 miles of new roads, and 43% of the aggregate will be used on roads. Private logging and forestry roads will account for 22% of this.

Growth in Lincoln County will come largely from tourism and households headed by people over the age of 64. As a result, nonresidential construction will favor medical buildings, lodging, and retailers as opposed to schools, offices, and manufacturers. This limits the markets for aggregate. Only 18% of the aggregate used during the forecast period will go into nonresidential construction. That compares to 29% for the whole state.

Total aggregate consumption will equal 47.3 million tons. Recycling will satisfy 4.7% of that need, leaving 45.0 million tons of virgin aggregate consumption. On an annual basis, virgin aggregate use will be 900,742 tons and will grow at a rate of 0.27% per year.

Table 3.43

Forecast of Annual Average Aggregate Consumption for Lincoln County (in tons)

	2001-2010	*2011-2020*	*2021-2030*	*2031-2040*	*2041-2050*
End Use:					
Residential Construction	120,655	127,774	131,984	138,449	141,490
Nonresidential	140,523	150,326	164,648	178,168	196,557
Roads	405,597	408,986	406,766	407,053	404,749
Other Infrastructure	178,184	190,210	201,835	213,922	225,626
Miscellaneous Uses	34,629	36,885	39,042	41,052	43,117
Total Consumption	879,588	914,182	944,275	978,645	1,011,540
Less Recycled Materials	(32,180)	(38,267)	(44,495)	(51,265)	(58,314)
Virgin Aggregate Use	847,408	875,914	899,780	927,380	953,227
Tons Per Capita	19.0	18.1	17.3	16.6	15.9

Table 3.44

Forecast of Population, Housing, and Road Mileage Data for Lincoln County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	9,662	10,519	11,062	11,819	12,455	13,325
18 to 64 Years Old	24,444	27,060	28,106	28,394	30,226	32,413
Over 64 Years Old	8,477	8,634	10,858	13,680	15,045	15,873
Total Population	42,583	46,213	50,026	53,893	57,726	61,611
10-Year % Growth	9.5%	8.5%	8.3%	7.7%	7.1%	6.7%
Personal Income (Mn. 1987$)	$603	$694	$800	$921	$1,060	$1,220
10-Year % Growth	16.1%	15.0%	15.3%	15.2%	15.0%	15.1%
Housing Stock (Units):						
SF Site-Built Homes	16,274	17,350	18,543	19,787	21,125	22,465
SF Manufactured Homes	4,222	5,013	5,707	6,281	6,763	7,126
Multi-family Housing Units	3,454	3,901	4,367	4,831	5,309	5,768
Other Housing	1,215	1,291	1,380	1,458	1,534	1,600
Less Vacant & Seasonal	(6,963)	(7,818)	(8,454)	(9,098)	(9,706)	(10,269)
Total Households	18,202	19,735	21,543	23,259	25,025	26,690
Road Mileage:						
Gravel	608	606	603	602	600	599
Asphalt and Oil Mat	591	603	615	627	639	649
Concrete	1	1	1	1	1	1
Total Road Mileage	1,200	1,210	1,220	1,230	1,240	1,250
Road Miles Per 100 Households	6.59	6.13	5.66	5.29	4.95	4.68

Linn County

Linn County grew steadily until the early 1980s, when a recession caused an outward migration. The decline was short lived and growth resumed. With a good industrial base and transportation infrastructure, the county's population will grow at a 1.17% rate between 2001 and 2050.

Unlike many coastal and rural counties, Linn County's population growth will be fairly balanced between seniors, working adults, and children. This is better for the economy. The combination of substantial gains in both the number of working households and personal incomes will stimulate construction activity. Large quantities of aggregate will be needed for offices, factories, and warehouses.

The number of households will increase by 34,137. Multi-family units will make up 27% of the new and replacement housing built during the forecast period. Single-family site-built homes, with a 51% share, will dominate the market. Vacation homes are a very minor part of the housing stock.

Linn County ranks fifth in the state in miles of improved roads. The county will add another 155 miles during the forecast period. Logging and forest related roads are an important factor and account for 6% of the county's aggregate consumption. There are over 500 miles of BLM and USFS roads in Linn County.

Total aggregate consumption from 2001 to 2050 will be 101.5 million tons, with 6.7 million tons coming from recycled materials. Virgin aggregate consumption will average 1,895,995 tons a year and rise at a 0.44% rate during the forecast period. A total of 94.8 million tons will be consumed.

Table 3.45

Forecast of Annual Average Aggregate Consumption for Linn County (in tons)

	2001-2010	*2011-2020*	*2021-2030*	*2031-2040*	*2041-2050*
End Use:					
Residential Construction	284,423	312,016	324,993	346,475	360,392
Nonresidential	392,496	438,382	490,717	538,655	601,639
Roads	775,777	783,039	777,702	779,208	775,846
Other Infrastructure	246,178	277,214	306,437	336,648	366,119
Miscellaneous Uses	107,031	117,537	127,494	136,790	146,339
Total Consumption	1,805,905	1,928,189	2,027,342	2,137,775	2,250,335
Less Recycled Materials	(84,042)	(107,537)	(131,725)	(158,591)	(187,674)
Virgin Aggregate Use	1,721,863	1,820,652	1,895,617	1,979,184	2,062,661
Tons Per Capita	14.9	13.8	12.7	11.9	11.3

Table 3.46

Forecast of Population, Housing, and Road Mileage Data for Linn County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	27,131	30,571	33,833	37,711	41,138	45,300
18 to 64 Years Old	64,442	74,762	81,737	86,238	95,014	104,876
Over 64 Years Old	15,115	17,259	23,837	32,509	37,198	40,302
Total Population	106,688	122,592	139,407	156,458	173,350	190,478
10-Year % Growth	17.2%	14.9%	13.7%	12.2%	10.8%	9.9%
Personal Income (Mn. 1987$)	$1,431	$1,754	$2,134	$2,568	$3,058	$3,620
10-Year % Growth	22.4%	22.6%	21.6%	20.3%	19.1%	18.4%
Housing Stock (Units):						
SF Site-Built Homes	28,430	31,764	35,549	39,453	43,656	47,941
SF Manufactured Homes	6,750	8,850	10,743	12,300	13,634	14,695
Multi-family Housing Units	7,215	8,801	10,556	12,334	14,223	16,125
Other Housing	1,511	1,627	1,728	1,788	1,817	1,804
Less Vacant & Seasonal	(2,515)	(3,167)	(3,651)	(4,096)	(4,547)	(5,037)
Total Households	41,391	47,875	54,925	61,778	68,783	75,528
Road Mileage:						
Gravel	858	852	846	841	838	835
Asphalt and Oil Mat	1,736	1,767	1,799	1,829	1,860	1,891
Concrete	37	42	47	52	57	61
Total Road Mileage	2,631	2,660	2,691	2,722	2,755	2,787
Road Miles Per 100 Households	6.36	5.56	4.90	4.41	4.01	3.69

Malheur County

Malheur County's population grew sharply in the 1970s and then suffered a loss in the 1980s. Its population is rising once again, and our forecast has it increasing at a rate of 0.78% a year from 2001 to 2050. A high level of births in the county will more than offset losses due to outward migration.

During the forecast period, 60% of the population growth will be split between people under 18 years old and those over 64. The county will rank at or next to last in per capita income in each year of our forecast. While the number of households will go up by 5,249, Malheur County will remain far from prosperous. This will keep the consumption of aggregate from rising substantially.

The housing stock will increase by 5,834 units. Since the county is large and sparsely populated, manufactured housing is favored. It will make up 66% of the housing stock increase. The rest will be split between multi-family and site-built single-family homes.

The county will add just 27 miles of new roads. Logging activity is low and accounts for less than 1% of the aggregate used. There are only about 170 miles of road under the jurisdictions of the BLM and State Forestry Department in Malheur County.

The largest nonresidential use is farming and ranching. Other significant uses include detention centers and warehouses.

Total consumption from 2001 to 2050 will be 40.7 million tons. Of that, 1.9 million tons will come from recycled materials. The growth rate of virgin aggregate consumption will be 0.16%. An average of 776,220 tons per year will be used, or 38.8 million tons during the entire forecast period. The county currently exports some aggregate to Idaho.

Table 3.47

Forecast of Annual Average Aggregate Consumption for Malheur County (in tons)

	2001-2010	2011-2020	2021-2030	2031-2040	2041-2050
End Use:					
Residential Construction	50,950	58,129	61,044	64,676	66,822
Nonresidential	187,726	192,243	202,236	213,222	228,831
Roads	442,081	448,178	443,637	441,847	437,703
Other Infrastructure	65,979	70,681	74,933	79,587	84,337
Miscellaneous Uses	28,857	30,417	31,905	33,289	34,714
Total Consumption	775,592	799,649	813,755	832,620	852,407
Less Recycled Materials	(28,370)	(33,468)	(38,340)	(43,612)	(49,137)
Virgin Aggregate Use	747,222	766,182	775,415	789,008	803,270
Tons Per Capita	24.9	23.5	21.9	20.7	19.7

Table 3.48

Forecast of Population, Housing, and Road Mileage Data for Malheur County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	8,481	9,273	9,793	10,445	11,059	11,862
18 to 64 Years Old	15,697	17,352	18,124	18,386	19,648	21,124
Over 64 Years Old	4,386	4,513	5,927	7,757	8,600	9,078
Total Population	28,564	31,138	33,844	36,588	39,307	42,064
10-Year % Growth	9.9%	9.0%	8.7%	8.1%	7.4%	7.0%
Personal Income (Mn. 1987$)	$348	$393	$447	$512	$591	$687
10-Year % Growth	11.5%	12.8%	13.9%	14.6%	15.3%	16.3%
Housing Stock (Units):						
SF Site-Built Homes	7,330	7,346	7,493	7,715	8,030	8,416
SF Manufactured Homes	2,457	3,307	4,202	5,002	5,713	6,290
Multi-family Housing Units	1,424	1,594	1,805	2,019	2,240	2,453
Other Housing	260	248	233	211	182	146
Less Vacant & Seasonal	(1,054)	(1,154)	(1,257)	(1,388)	(1,515)	(1,639)
Total Households	10,417	11,341	12,476	13,559	14,650	15,666
Road Mileage:						
Gravel	995	989	982	976	971	966
Asphalt and Oil Mat	931	942	954	965	977	987
Concrete	2	2	3	3	3	3
Total Road Mileage	1,929	1,933	1,939	1,945	1,950	1,956
Road Miles Per 100 Households	18.52	17.05	15.54	14.34	13.31	12.49

Marion County

Marion is the third most densely populated county in Oregon. Its economy has expanded at a good rate for most of the past 35 years. This will continue as the county is well located, has excellent infrastructure, and productive farmland.

Our forecast shows the number of households rising by 78,957 between the years 2001 and 2050. Significant increases will occur in all three major age groups. The only negative feature to the forecast is the county's per capita income ranking. It will remain around 13th. That is a low level for a largely urban county in Oregon.

In 1990, 89% of the residents lived in towns or cities. By 2050, this will rise to 94%. Because of this high urbanization, 36% of the new housing put in place during the forecast period will be multi-family. For single-family homes, site-built construction will remain the preferred type of housing.

The number of road miles per person in Marion County is low. The increase in households will stimulate 381 miles of new roads. Because there will be so much construction activity in other sectors, roads will account for only 19% of total aggregate consumption. The county has relatively few federal and state forest roads. Logging will make up less than 1% of the total consumption.

Marion County will consume 188.7 million tons of aggregate during the 50-year forecast interval. Recycling will be an important source, adding 14.1 million tons to supply. Virgin aggregate consumption will equal 174.6 million tons, or 3,491,226 tons a year. It will grow at an annual rate of 0.53%. In recent years Marion County has been a modest net exporter of sand and gravel.

Table 3.49

Forecast of Annual Average Aggregate Consumption for Marion County (in tons)

	2001-2010	*2011-2020*	*2021-2030*	*2031-2040*	*2041-2050*
End Use:					
Residential Construction	628,522	697,089	723,492	771,082	803,499
Nonresidential	992,229	1,111,464	1,261,399	1,406,599	1,593,632
Roads	702,612	726,694	730,663	749,440	760,315
Other Infrastructure	599,945	674,912	743,483	814,920	883,608
Miscellaneous Uses	249,849	275,522	300,087	323,035	346,607
Total Consumption	3,173,157	3,485,681	3,759,124	4,065,076	4,387,662
Less Recycled Materials	(177,682)	(225,878)	(276,541)	(334,706)	(399,763)
Virgin Aggregate Use	2,995,475	3,259,803	3,482,583	3,730,370	3,987,899
Tons Per Capita	9.9	9.5	9.1	8.8	8.5

Table 3.50

Forecast of Population, Housing, and Road Mileage Data for Marion County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	72,108	81,985	90,121	99,896	108,503	119,023
18 to 64 Years Old	171,892	196,667	213,602	224,213	245,944	270,425
Over 64 Years Old	36,438	41,077	57,282	78,747	89,873	96,919
Total Population	280,438	319,729	361,005	402,856	444,320	486,367
10-Year % Growth	22.2%	14.0%	12.9%	11.6%	10.3%	9.5%
Personal Income (Mn. 1987$)	$3,969	$4,803	$5,787	$6,927	$8,240	$9,781
10-Year % Growth	27.2%	21.0%	20.5%	19.7%	19.0%	18.7%
Housing Stock (Units):						
SF Site-Built Homes	71,544	80,122	89,673	99,092	108,917	118,653
SF Manufactured Homes	9,842	12,340	14,632	16,482	18,044	19,250
Multi-family Housing Units	24,875	29,693	35,149	40,621	46,422	52,243
Other Housing	3,338	3,611	3,889	4,097	4,262	4,357
Less Vacant & Seasonal	(6,159)	(7,720)	(8,844)	(9,866)	(10,904)	(12,105)
Total Households	103,440	118,045	134,499	150,426	166,742	182,397
Road Mileage:						
Gravel	493	491	489	489	490	493
Asphalt and Oil Mat	1,839	1,899	1,964	2,028	2,094	2,161
Concrete	100	111	124	136	148	160
Total Road Mileage	2,432	2,501	2,577	2,653	2,732	2,813
Road Miles Per 100 Households	2.35	2.12	1.92	1.76	1.64	1.54

Morrow County

Morrow County experienced uneven growth in the past. As is typical of a county with a small population, Morrow has seen periods of sudden increases followed by marked slowdowns. A single construction project can cause an exaggerated jump in aggregate demand and employment.

Overall, however, the county has grown. This is expected to continue especially in the northern part of the county. Our forecast shows the number of households rising by 1.08% per year for an increase of 2,282.

Morrow County has a young population compared to the rest of Oregon. It will get older. The county's share of citizens over 64 years old will rise during the forecast from 10% to 20%. That, however, will only put Morrow County even with the state as a whole.

Morrow County has been able to attract a small inward migration of working-age families. The forecast assumes that this trend will continue. The county has certain advantages such as rail, interstate highway, and Columbia River access.

Residential construction will take up 5% of the aggregate consumption forecast for the 2001 to 2050 period. Manufactured homes will account for 47% of the new housing put in place. Seventeen percent will be multi-family housing, and the remaining 36% will be site-built single-family homes.

Morrow County will add 45 miles of paved roads, although 31 miles will come from resurfacing existing gravel roads. Logging and USFS roads will use 2% of the county's aggregate. About 8% will be used on ranches, farms, and agricultural buildings.

Total aggregate consumption during the 50-year forecast period will be 23.7 million tons. Recycling will furnish 1.1 million tons, and 22.6 million tons will come from mines and quarries. Virgin aggregate consumption will grow at a rate of 0.02% and average 451,532 tons a year. The county's production will grow significantly, if efforts to expand aggregate barging to markets down the Columbia River are successful.

Table 3.51

Forecast of Annual Average Aggregate Consumption for Morrow County (in tons)

	2001-2010	2011-2020	2021-2030	2031-2040	2041-2050
End Use:					
Residential Construction	18,762	21,884	23,073	24,773	26,028
Nonresidential	103,960	106,384	109,752	113,171	118,270
Roads	263,762	264,111	258,864	255,982	252,045
Other Infrastructure	64,468	66,264	67,825	69,613	71,464
Miscellaneous Uses	12,522	13,198	13,843	14,440	15,059
Total Consumption	463,474	471,842	473,357	477,979	482,866
Less Recycled Materials	(16,950)	(19,745)	(22,300)	(25,033)	(27,832)
Virgin Aggregate Use	446,524	452,097	451,057	452,946	455,035
Tons Per Capita	48.5	43.7	39.1	35.6	32.7

Table 3.52

Forecast of Population, Housing, and Road Mileage Data for Morrow County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	2,381	2,677	2,919	3,209	3,471	3,791
18 to 64 Years Old	5,106	5,799	6,252	6,520	7,115	7,790
Over 64 Years Old	1,109	1,237	1,716	2,348	2,668	2,868
Total Population	8,596	9,713	10,887	12,077	13,254	14,449
10-Year % Growth	12.4%	13.0%	12.1%	10.9%	9.7%	9.0%
Personal Income (Mn. 1987$)	$111	$130	$152	$178	$209	$245
10-Year % Growth	3.5%	16.7%	17.0%	17.1%	17.1%	17.6%
Housing Stock (Units):						
SF Site-Built Homes	1,819	1,925	2,091	2,284	2,513	2,770
SF Manufactured Homes	1,269	1,525	1,810	2,063	2,292	2,483
Multi-family Housing Units	383	446	527	611	700	791
Other Housing	193	187	176	157	129	93
Less Vacant & Seasonal	(467)	(464)	(508)	(556)	(606)	(658)
Total Households	3,197	3,619	4,097	4,559	5,029	5,479
Road Mileage:						
Gravel	608	601	594	588	582	577
Asphalt and Oil Mat	601	611	621	629	638	645
Concrete	0	0	0	0	1	1
Total Road Mileage	1,209	1,212	1,215	1,218	1,220	1,223
Road Miles Per 100 Households	37.82	33.48	29.65	26.71	24.26	22.32

Multnomah County

From 1970 to 1987, Multnomah County's population grew at an annual rate of only 0.06%. The number of households grew by 0.95%, because the county's average family size dropped from 2.8 people to 2.4. Still, the county's growth rate was very low compared to the rest of Oregon. Since then, however, there has been a sharp turnaround.

From 2001 to 2050, we expect the population to rise by 0.53% a year. The number of households will climb by 88,667.

Multnomah County's population, compared to the rest of Oregon, is biased in favor of 18- to 64-year-olds. This tendency to attract and maintain wage earners ensures that Multnomah County will keep its top ranking in per capita personal income. This is a major factor behind the county's high level of aggregate consumption.

Multnomah is the smallest, yet most populous county in Oregon. With 99% of the population living in towns, cities, and suburbs, roads are heavily used. Because of this, Multnomah County has the fewest miles of road per capita. Over the forecast period, roads will account for only 12% of the county's total aggregate consumption. Far more aggregate will be used for other types of construction.

There will be an increase of 97,979 units in the housing stock. Multi-family housing will account for half of the new units put in place. High-rise apartment buildings will make up 17% of the total.

The county will add 590 miles of roads in the 50-year forecast period. Aggregate consumption for logging roads, which are common in the eastern part of the county, is overshadowed by other markets and accounts for less than 0.2% of total demand.

Aggregate consumption from 2001 to 2050 will be 389.4 million tons. The construction industry recycles large quantities of aggregate in Multnomah County. This activity will grow, and over the forecast period we expect that 34.9 million tons of aggregate will come from recycled materials. Virgin aggregate consumption will total 354.6 million tons or 7,091,558 tons a year. It will grow at a 0.38% rate per year. Currently, the county is a net importer of aggregate from Clark and Columbia Counties.

Table 3.53

Forecast of Annual Average Aggregate Consumption for Multnomah County (in tons)

	2001-2010	2011-2020	2021-2030	2031-2040	2041-2050
End Use:					
Residential Construction	1,182,289	1,191,045	1,204,855	1,278,858	1,310,658
Nonresidential	2,478,487	2,672,843	2,939,856	3,179,824	3,455,187
Roads	926,073	935,995	951,442	997,685	1,023,671
Other Infrastructure	1,907,450	2,002,625	2,094,048	2,201,149	2,302,717
Miscellaneous Uses	502,260	521,703	541,923	560,659	580,002
Total Consumption	6,996,559	7,324,210	7,732,125	8,218,175	8,672,235
Less Recycled Materials	(496,605)	(584,338)	(684,691)	(799,811)	(920,070)
Virgin Aggregate Use	6,499,954	6,739,872	7,047,434	7,418,364	7,752,165
Tons Per Capita	9.7	9.6	9.5	9.5	9.4

Table 3.54

Forecast of Population, Housing, and Road Mileage Data for Multnomah County

	2000	*2010*	*2020*	*2030*	*2040*	*2050*
Population:						
0 to 17 Years Old	142,797	145,259	149,762	158,291	163,562	171,845
18 to 64 Years Old	427,620	464,040	471,907	468,846	489,900	516,081
Over 64 Years Old	75,533	75,021	101,057	134,533	146,790	151,449
Total Population	645,950	684,320	722,726	761,670	800,252	839,375
10-Year % Growth	10.7%	5.9%	5.6%	5.4%	5.1%	4.9%
Personal Income (Mn. 1987$)	$11,618	$13,068	$14,736	$16,676	$18,920	$21,553
10-Year % Growth	15.8%	12.5%	12.8%	13.2%	13.5%	13.9%
Housing Stock (Units):						
SF Site-Built Homes	180,941	191,638	201,019	209,547	218,832	227,685
SF Manufactured Homes	5,460	7,666	9,432	10,828	12,049	12,990
Multi-family Housing Units	96,267	106,369	115,393	123,666	132,673	141,300
Other Housing	4,687	4,560	4,355	4,070	3,748	3,358
Less Vacant & Seasonal	(15,943)	(19,451)	(21,129)	(22,636)	(23,859)	(25,255)
Total Households	271,412	290,782	309,070	325,475	343,443	360,079
Road Mileage:						
Gravel	127	130	132	135	137	141
Asphalt and Oil Mat	2,806	2,912	3,014	3,117	3,228	3,342
Concrete	156	166	174	182	190	198
Total Road Mileage	3,090	3,207	3,321	3,434	3,556	3,680
Road Miles Per 100 Households	1.14	1.10	1.07	1.06	1.04	1.02

Polk County

Except for a few years in the mid-1980s, Polk County's population grew steadily. Most of the increase resulted from a large inward migration of working families. The forecast shows this pattern extending into the future, although at a gradually slowing rate.

From 2001 to 2050, the number of households will go up by 19,927. In addition, the county's ranking in per capita income will improve from 27th in 1993 to 18th in 2050. Reflecting the growth in income and working-age population, construction activity in Polk County will be broadly based. This will drive aggregate consumption higher.

Polk County has the seventh highest population density in Oregon. Over 77% of residents live in towns and cities. With the population rising 1.23% per year, the level of urbanization will approach 85% by 2050. In these circumstances, multi-family housing becomes more popular, and we expect it will take up 32% of the new units put in place. For single-family homes, site-built units will maintain their dominant share of the market and beat out manufactured units by a three-to-one ratio.

Polk County has an extensive road system. In 1993, only two counties in the state had more roads per square mile. The county will add 86 miles of roads from 2001 to 2050. Almost half of the county's road mileage in our forecast is under the jurisdiction of the BLM or State Forestry Department. Aggregate for those roads and private logging makes up 10% of the county's projected consumption.

Total aggregate consumption will be 53.7 million tons during the forecast period. Recycling will total 3.7 million tons. Virgin aggregate consumption will be 50.0 million tons, or 999,186 tons a year. It will increase at a 0.54% rate from 2001 to 2050.

Table 3.55

Forecast of Annual Average Aggregate Consumption for Polk County (in tons)

	2001-2010	2011-2020	2021-2030	2031-2040	2041-2050
End Use:					
Residential Construction	161,831	173,142	180,826	193,137	201,013
Nonresidential	179,447	211,707	245,654	277,585	319,654
Roads	356,304	352,476	346,584	345,250	341,567
Other Infrastructure	182,560	205,455	227,533	250,053	271,899
Miscellaneous Uses	56,634	63,282	69,583	75,471	81,513
Total Consumption	936,776	1,006,063	1,070,180	1,141,495	1,215,646
Less Recycled Materials	(47,769)	(60,153)	(73,366)	(88,269)	(104,670)
Virgin Aggregate Use	889,007	945,909	996,814	1,053,226	1,110,975
Tons Per Capita	13.2	12.2	11.3	10.7	10.2

Table 3.56

Forecast of Population, Housing, and Road Mileage Data for Polk County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	15,885	17,587	19,622	22,027	24,147	26,700
18 to 64 Years Old	37,073	44,119	48,628	51,641	57,181	63,374
Over 64 Years Old	8,752	9,898	13,823	19,023	21,883	23,803
Total Population	61,710	71,604	82,073	92,691	103,211	113,877
10-Year % Growth	24.2%	16.0%	14.6%	12.9%	11.3%	10.3%
Personal Income (Mn. 1987$)	$820	$1,016	$1,248	$1,514	$1,819	$2,171
10-Year % Growth	28.3%	23.9%	22.8%	21.4%	20.1%	19.4%
Housing Stock (Units):						
SF Site-Built Homes	15,687	17,805	20,051	22,332	24,752	27,182
SF Manufactured Homes	2,559	3,567	4,435	5,146	5,749	6,223
Multi-family Housing Units	4,621	5,771	6,994	8,240	9,566	10,901
Other Housing	506	526	526	503	459	392
Less Vacant & Seasonal	(1,289)	(1,636)	(1,908)	(2,164)	(2,422)	(2,686)
Total Households	22,085	26,033	30,098	34,057	38,103	42,012
Road Mileage:						
Gravel	1,194	1,186	1,179	1,174	1,170	1,168
Asphalt and Oil Mat	535	557	578	597	616	634
Concrete	19	22	25	28	31	33
Total Road Mileage	1,749	1,765	1,782	1,799	1,817	1,835
Road Miles Per 100 Households	7.92	6.78	5.92	5.28	4.77	4.37

Sherman County

The population of Sherman County fell by 598 from 1960 to 1995. This was a large drop, considering that the county has the third smallest population in Oregon. The performance is a reflection of inadequate job creation, particularly in agriculture. Unlike farms in the Willamette Valley, most of those in Sherman County are large wheat-growing operations. They have used less hired labor and become more capital intensive in recent years. They also stimulate relatively little local downstream processing.

In our forecast, the number of households falls until 2010. We expect it to increase slightly after that. By 2050, it will reach 784 or about where it was in the mid-1970s. However, because of insufficient job growth, the county will have trouble keeping working families. By 2050, 28% of the county's population will be over 64 years of age.

From 2001 to 2050, the number of households will fall by 10. The county will lose 186 residents under 64 years of age and gain 117 over 64. The county's ranking in per capita income will also fall. In 1993, it ranked fourth in the state. By 2050, it will fall to sixth. These rankings depend heavily on farm revenues from wheat.

The stock of housing in Sherman County will rise by 38 units during the forecast period. This increase is entirely due to construction of seasonal, recreational, and vacation homes. Only 54% of the population lives in towns. For that reason, single-family housing has an overwhelming share of the market. As is typical of sparsely populated areas, where it is expensive to built site-built homes, manufactured housing is preferred and will take up a growing share of the housing stock in the future.

Sherman County does not have any commercial logging activity. Farms, ranches, and agriculture will account for 9% of the county's aggregate consumption. Road work is the biggest market and uses 64% of the county's aggregate. Sherman County has the third highest number of road miles per resident in Oregon.

Total aggregate consumption will be 9.8 million tons. Virgin aggregate consumption will fall at a 0.08% rate from 2001 to 2050 and total 9.4 million tons for the whole period. The average annual consumption will be 187,146 tons.

Table 3.57

Forecast of Annual Average Aggregate Consumption for Sherman County (in tons)

	2001-2010	2011-2020	2021-2030	2031-2040	2041-2050
End Use:					
Residential Construction	1,789	2,811	3,056	3,159	3,219
Nonresidential	52,647	52,435	52,022	51,683	51,465
Roads	125,334	126,175	124,438	124,463	124,483
Other Infrastructure	13,588	13,369	13,283	13,268	13,272
Miscellaneous Uses	3,259	3,214	3,195	3,176	3,157
Total Consumption	196,617	198,005	195,994	195,749	195,597
Less Recycled Materials	(7,191)	(8,285)	(9,232)	(10,251)	(11,273)
Virgin Aggregate Use	189,425	189,720	186,762	185,498	184,324
Tons Per Capita	112.8	116.7	113.5	111.3	109.3

Table 3.58

Forecast of Population, Housing, and Road Mileage Data for Sherman County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	454	404	394	394	394	404
18 to 64 Years Old	948	872	852	802	802	812
Over 64 Years Old	362	339	389	459	479	479
Total Population	1,764	1,615	1,635	1,655	1,675	1,695
10-Year % Growth	-9.5%	-8.4%	1.2%	1.2%	1.2%	1.2%
Personal Income (Mn. 1987$)	$30	$29	$30	$32	$34	$37
10-Year % Growth	-10.3%	-5.6%	5.3%	6.3%	7.2%	8.2%
Housing Stock (Units):						
SF Site-Built Homes	566	536	528	527	530	535
SF Manufactured Homes	275	268	290	316	339	357
Multi-family Housing Units	23	22	22	23	24	25
Other Housing	46	40	38	36	34	31
Less Vacant & Seasonal	(117)	(132)	(124)	(138)	(152)	(164)
Total Households	794	734	754	764	774	784
Road Mileage:						
Gravel	279	281	281	280	280	280
Asphalt and Oil Mat	254	252	253	253	254	254
Concrete	1	1	1	1	1	1
Total Road Mileage	534	534	534	534	535	535
Road Miles Per 100 Households	67.20	72.73	70.84	69.95	69.09	68.26

Tillamook County

Tillamook County's population grew substantially in the 1970s, but that period was sandwiched in between two weak decades. Growth has recently picked up, and it will continue at a moderate pace throughout the forecast period.

The county will add 4,951 households between the years 2001 and 2050. Many of these will be of retirees. By 2050, 28% of the population will be over 64 years of age. Because it has large numbers of retirees on limited incomes, Tillamook County's per capita income ranked only 34th in the state in 1993. By 2050, it will rise to just 32nd. Low incomes and growth that is biased away from prime working-age families act as drags on the county's aggregate forecast.

Compared to its population density, Tillamook has an unusually high percentage of rural households. On average, over a third of the residents during the forecast period will live outside towns and cities. Multi-family housing will make up only 12% of the new units put in place.

The county will see its housing stock rise by 7,937 units. Vacation, seasonal, and recreation houses will increase in number by 2,429 units. A very high proportion of the housing in Tillamook County is seasonal.

Roads will use 47% of the county's aggregate. Thirty-four miles of new roads will be added and five miles of existing gravel roads will be resurfaced with asphalt. Logging and forest roads will account for 15% of the total consumption. Forestry used to be a much larger factor in the market, but cutbacks in logging have hurt aggregate consumption.

Total aggregate consumption will be 28.9 million tons between 2001 and 2050. Recycled materials will make up 1.4 million tons of this. Virgin aggregate consumption will average 549,640 tons per year for a total of 27.5 million. It will grow at a 0.21% rate.

Table 3.59

Forecast of Annual Average Aggregate Consumption for Tillamook County (in tons)

	2001-2010	*2011-2020*	*2021-2030*	*2031-2040*	*2041-2050*
End Use:					
Residential Construction	83,514	87,111	90,512	95,082	97,445
Nonresidential	72,554	77,245	85,487	93,534	105,017
Roads	272,621	274,194	273,323	273,928	273,183
Other Infrastructure	92,727	97,456	102,166	107,171	112,211
Miscellaneous Uses	21,207	22,472	23,762	24,962	26,198
Total Consumption	542,623	558,479	575,250	594,677	614,055
Less Recycled Materials	(19,848)	(23,377)	(27,106)	(31,151)	(35,400)
Virgin Aggregate Use	522,774	535,102	548,144	563,526	578,655
Tons Per Capita	20.3	19.1	18.1	17.3	16.6

Table 3.60

Forecast of Population, Housing, and Road Mileage Data for Tillamook County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	5,443	6,015	6,333	6,767	7,142	7,656
18 to 64 Years Old	13,670	15,082	15,691	15,861	16,914	18,172
Over 64 Years Old	5,375	5,653	7,012	8,726	9,595	10,153
Total Population	24,488	26,750	29,036	31,354	33,651	35,981
10-Year % Growth	13.9%	9.2%	8.5%	8.0%	7.3%	6.9%
Personal Income (Mn. 1987$)	$304	$348	$398	$458	$527	$610
10-Year % Growth	16.6%	14.3%	14.5%	14.9%	15.2%	15.7%
Housing Stock (Units):						
SF Site-Built Homes	10,913	11,522	12,203	12,955	13,799	14,683
SF Manufactured Homes	2,707	3,612	4,403	5,082	5,667	6,129
Multi-family Housing Units	1,096	1,268	1,441	1,613	1,791	1,962
Other Housing	725	720	712	689	654	604
Less Vacant & Seasonal	(5,276)	(6,055)	(6,642)	(7,218)	(7,765)	(8,262)
Total Households	10,164	11,066	12,117	13,122	14,146	15,115
Road Mileage:						
Gravel	288	287	286	285	284	283
Asphalt and Oil Mat	568	576	584	591	599	606
Concrete	2	2	2	2	2	3
Total Road Mileage	858	865	871	878	885	892
Road Miles Per 100 Households	8.44	7.81	7.19	6.69	6.26	5.90

Umatilla County

The population of Umatilla County jumped 32% from 1971 to 1981, but then fell. Since 1988, however, the population has resumed its upward trend. Our forecast shows this continuing. From 2001 to 2050, the number of households will go up at an annual rate of 0.90%. The county will add 14,288 households with a favorable mixture of age groups. This will result in a wide range of construction projects and fairly healthy demand for aggregate.

The county's housing stock will grow only slightly faster than the number of households. An increase of 15,663 is expected. That is largely because there are few vacation and seasonal homes in Umatilla County.

The population of Umatilla County tends to be concentrated in towns and cities. By 2050, over 86% of the residents will live in areas with more than one home per ten acres. Multi-family housing and site-built single-family homes, therefore, will be popular. During the forecast period, 29% of the new units put in place will be multi-family.

The county will add 70 miles of new roads and pave 79 miles of existing gravel roads. Overall, roads will use 38% of the county's projected aggregate consumption. Logging and forest-related roads take up 1% of the total.

Total aggregate consumption will be 60.2 million tons. After subtracting 2.9 million tons of recycled materials, we get 57.3 million tons of virgin aggregate consumption. That equals 1,146,008 tons a year. The growth rate is 0.26%.

Table 3.61

Forecast of Annual Average Aggregate Consumption for Umatilla County (in tons)

	2001-2010	2011-2020	2021-2030	2031-2040	2041-2050
End Use:					
Residential Construction	125,677	133,491	139,274	148,686	154,414
Nonresidential	271,302	290,382	315,196	340,321	376,384
Roads	478,837	468,294	455,051	456,495	451,727
Other Infrastructure	173,618	185,230	196,698	209,830	222,887
Miscellaneous Uses	76,947	80,761	84,536	88,044	91,659
Total Consumption	1,126,380	1,158,158	1,190,755	1,243,375	1,297,071
Less Recycled Materials	(41,194)	(48,478)	(56,110)	(65,137)	(74,781)
Virgin Aggregate Use	1,085,186	1,109,680	1,134,644	1,178,238	1,222,290
Tons Per Capita	15.5	14.5	13.6	13.0	12.5

Table 3.62

Forecast of Population, Housing, and Road Mileage Data for Umatilla County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	17,141	18,258	19,472	21,067	22,407	24,143
18 to 64 Years Old	40,248	45,413	47,845	48,984	52,623	56,836
Over 64 Years Old	8,667	9,115	12,388	16,670	18,643	19,744
Total Population	66,056	72,786	79,705	86,721	93,673	100,723
10-Year % Growth	12.0%	10.2%	9.5%	8.8%	8.0%	7.5%
Personal Income (Mn. 1987$)	$833	$950	$1,090	$1,258	$1,459	$1,706
10-Year % Growth	13.8%	14.0%	14.7%	15.4%	16.0%	16.9%
Housing Stock (Units):						
SF Site-Built Homes	15,968	17,070	18,314	19,651	21,165	22,760
SF Manufactured Homes	5,456	6,743	7,914	8,912	9,788	10,476
Multi-family Housing Units	5,036	5,846	6,699	7,556	8,463	9,358
Other Housing	840	802	737	641	519	369
Less Vacant & Seasonal	(2,035)	(2,295)	(2,552)	(2,849)	(3,126)	(3,410)
Total Households	25,265	28,165	31,112	33,911	36,809	39,553
Road Mileage:						
Gravel	1,158	1,138	1,119	1,104	1,090	1,079
Asphalt and Oil Mat	1,143	1,171	1,198	1,221	1,245	1,266
Concrete	61	67	73	78	84	89
Total Road Mileage	2,363	2,376	2,390	2,404	2,418	2,433
Road Miles Per 100 Households	9.35	8.44	7.68	7.09	6.57	6.15

Union County

From 1960 to 1984, Union County's population jumped up 36%. After that, it declined. Recently, however, it resumed its upward trend. The population of Union County will grow 0.46% a year from 2001 to 2050. In that time, 2,918 new households will take up residences in the county.

Union County will increase its housing stock by 3,446 units. One in 14 of those units will be a vacation or recreational home. Multi-family units will make up 25% of the new housing put in place between 2001 and 2050. Site-built single-family homes will be 41% of the total. Those percentages are high because the population is concentrated in towns and cities.

Union statistically ranks near the middle for Oregon counties, according to most measures. Its ranking in road mileage, however, is low. One reason is that its residents are more likely to live in cities and towns than the county's population density would suggest. In 1990, over 64% of the population lived in three cities.

The county will add 17 miles of roads and resurface 18 miles of existing gravel roads with asphalt or oil mat pavements. Logging and forest roads will make up 4% of the county's aggregate consumption. Farms and ranches will use 6%.

Total aggregate consumption will be 22.6 million tons and 1.1 million will come from recycled materials. Virgin aggregate consumption will equal 21.5 million tons, or 430,406 tons per year. It will rise 0.05% a year.

Table 3.63

Forecast of Annual Average Aggregate Consumption for Union County (in tons)

	2001-2010	*2011-2020*	*2021-2030*	*2031-2040*	*2041-2050*
End Use:					
Residential Construction	42,329	43,409	44,189	46,475	47,362
Nonresidential	90,966	95,056	101,211	106,955	114,948
Roads	217,753	215,961	212,348	212,302	209,349
Other Infrastructure	58,166	60,533	62,750	65,437	67,867
Miscellaneous Uses	27,601	28,140	28,722	29,251	29,803
Total Consumption	436,815	443,098	449,220	460,420	469,329
Less Recycled Materials	(15,974)	(18,545)	(21,165)	(24,116)	(27,054)
Virgin Aggregate Use	420,841	424,554	428,055	436,304	442,276
Tons Per Capita	16.2	15.6	15.0	14.6	14.2

Table 3.64

Forecast of Population, Housing, and Road Mileage Data for Union County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	6,359	6,493	6,628	6,896	7,095	7,420
18 to 64 Years Old	15,245	16,128	16,262	16,008	16,630	17,431
Over 64 Years Old	3,580	3,874	4,904	6,209	6,693	6,891
Total Population	25,184	26,495	27,794	29,113	30,418	31,742
10-Year % Growth	6.7%	5.2%	4.9%	4.7%	4.5%	4.4%
Personal Income (Mn. 1987$)	$334	$372	$416	$466	$523	$590
10-Year % Growth	11.6%	11.6%	11.7%	12.1%	12.3%	12.7%
Housing Stock (Units):						
SF Site-Built Homes	7,076	7,247	7,445	7,666	7,942	8,237
SF Manufactured Homes	1,993	2,448	2,831	3,141	3,411	3,617
Multi-family Housing Units	1,700	1,864	2,019	2,164	2,316	2,458
Other Housing	217	204	188	168	146	121
Less Vacant & Seasonal	(980)	(1,132)	(1,232)	(1,331)	(1,420)	(1,508)
Total Households	10,006	10,631	11,251	11,808	12,394	12,924
Road Mileage:						
Gravel	606	602	598	594	591	588
Asphalt and Oil Mat	495	501	507	512	517	522
Concrete	31	33	35	36	38	39
Total Road Mileage	1,132	1,136	1,139	1,142	1,146	1,149
Road Miles Per 100 Households	11.32	10.68	10.13	9.68	9.25	8.89

Wallowa County

Wallowa County has about the same population today as it did in 1960. The county is beginning to attract a significant inward migration. This will help it grow by 1,221 households during the forecast period. That is an annual rate of change of 0.68%. It is well below Oregon's average growth rate of 1.05%, but it is a big improvement for Wallowa County, compared to the past 35 years.

Much of the county's growth will come from retirees. The average age of the population is high and will go up even more in the future. This will weaken the county's personal income ranking.

Wallowa is a rural county. By 2050, only 65% of its residents will be living in towns and cities. As is typical in such places, manufactured homes will be more popular than site-built homes. They will account for 54% of the new units put in place during the forecast period. Multi-family units will make up only 10% of the total. The housing stock will increase by 2,016 units. Over a third of these will be vacation and seasonal housing.

The county will add only 18 new miles of paved roads in the 50-year forecast interval and half of these will come from resurfacing gravel roads. Logging and forest-related roads will use 6% of the county's aggregate. Three-fourths of this will go on USFS roads. Farms and ranches will use 9% of the county's aggregate and represent half of the nonresidential consumption.

Wallowa County's total aggregate consumption from 2001 to 2050 will be 15.8 million tons. Virgin aggregate consumption will total 15.1 million tons and will grow at a 0.07% rate. Annual virgin aggregate consumption will equal 301,186 tons.

Table 3.65

Forecast of Annual Average Aggregate Consumption for Wallowa County (in tons)

	2001-2010	2011-2020	2021-2030	2031-2040	2041-2050
End Use:					
Residential Construction	19,970	21,474	22,272	23,562	24,246
Nonresidential	57,846	59,010	60,711	62,756	66,375
Roads	200,575	202,243	200,264	200,116	198,791
Other Infrastructure	22,400	23,568	24,587	25,785	27,004
Miscellaneous Uses	6,786	7,129	7,429	7,711	7,999
Total Consumption	307,577	313,423	315,261	319,931	324,415
Less Recycled Materials	(11,250)	(13,116)	(14,852)	(16,757)	(18,699)
Virgin Aggregate Use	296,327	300,307	300,409	303,174	305,715
Tons Per Capita	39.4	37.2	34.8	32.9	31.3

Table 3.66

Forecast of Population, Housing, and Road Mileage Data for Wallowa County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	1,747	1,847	1,927	2,044	2,141	2,276
18 to 64 Years Old	4,220	4,653	4,793	4,808	5,084	5,414
Over 64 Years Old	1,286	1,263	1,607	2,045	2,239	2,348
Total Population	7,253	7,763	8,327	8,897	9,464	10,038
10-Year % Growth	4.4%	7.0%	7.3%	6.8%	6.4%	6.1%
Personal Income (Mn. 1987$)	$108	$121	$137	$156	$178	$204
10-Year % Growth	9.4%	12.0%	13.2%	13.6%	14.1%	14.7%
Housing Stock (Units):						
SF Site-Built Homes	2,956	2,983	3,049	3,140	3,264	3,410
SF Manufactured Homes	790	1,136	1,460	1,742	1,992	2,196
Multi-family Housing Units	248	282	319	355	392	427
Other Housing	94	91	89	84	79	71
Less Vacant & Seasonal	(1,106)	(1,288)	(1,448)	(1,610)	(1,762)	(1,901)
Total Households	2,982	3,204	3,468	3,711	3,964	4,203
Road Mileage:						
Gravel	585	584	581	579	578	576
Asphalt and Oil Mat	296	300	304	307	311	314
Concrete	0	0	0	0	0	0
Total Road Mileage	882	883	885	887	889	890
Road Miles Per 100 Households	29.57	27.57	25.53	23.90	22.42	21.18

Wasco County

The population of Wasco County grew at a rate of only 0.04% per year from 1960 to 1987. It has since shot up nearly 14% in just seven years. Our forecast has this growth rate slowing down, but still doing well. The county will benefit from its access to rail, an interstate highway, and the Columbia River. We expect the number of households to grow by 6,888 between the years 2001 and 2050.

With relatively few vacation homes in the county, the housing stock will increase only a little faster than the number of households. Out forecast calls for a gain of 7,627 units.

About three-fourths of Wasco County's residents live in towns and cities. Because of that, 28% of the new housing put in place will be multi-family, and most of the single-family homes will be site built. The county will add 36 miles of improved roads.

Logging and related road uses will account for 2% of the county's aggregate consumption. Farms and ranches will take 6% of the total. Overall, Wasco County's aggregate consumption will be spread over a wide variety of end uses. This reflects the forecast that shows the county with slightly above average growth and personal income per capita rates

Total consumption will be 32.0 million tons. Virgin aggregate consumption will be 30.5 million tons, or 610,029 tons per year. The consumption of virgin aggregate will rise at a 0.37% annual rate. Wasco County currently gets a large portion of its aggregate from Washington State.

Table 3.67

Forecast of Annual Average Aggregate Consumption for Wasco County (in tons)

	2001-2010	2011-2020	2021-2030	2031-2040	2041-2050
End Use:					
Residential Construction	51,010	63,081	66,439	70,525	73,616
Nonresidential	139,860	148,887	161,609	175,168	193,530
Roads	301,121	308,668	300,627	295,511	289,421
Other Infrastructure	59,312	66,408	72,415	78,882	85,626
Miscellaneous Uses	36,096	38,252	40,221	42,051	43,937
Total Consumption	587,400	625,295	641,311	662,137	686,130
Less Recycled Materials	(21,493)	(26,173)	(30,218)	(34,685)	(39,556)
Virgin Aggregate Use	565,907	599,122	611,093	627,451	646,574
Tons Per Capita	21.0	19.7	18.0	16.7	15.7

Table 3.68

Forecast of Population, Housing, and Road Mileage Data for Wasco County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	7,274	8,475	9,256	10,147	11,003	12,050
18 to 64 Years Old	13,492	15,434	16,672	17,390	19,026	20,879
Over 64 Years Old	4,394	4,536	6,068	8,060	9,135	9,852
Total Population	25,160	28,445	31,996	35,597	39,164	42,781
10-Year % Growth	15.9%	13.1%	12.5%	11.3%	10.0%	9.2%
Personal Income (Mn. 1987$)	$354	$420	$500	$593	$704	$837
10-Year % Growth	18.1%	18.5%	19.0%	18.8%	18.6%	18.9%
Housing Stock (Units):						
SF Site-Built Homes	6,511	6,864	7,475	8,147	8,893	9,682
SF Manufactured Homes	2,135	2,662	3,281	3,815	4,271	4,634
Multi-family Housing Units	1,857	2,135	2,541	2,959	3,395	3,828
Other Housing	523	534	550	551	538	509
Less Vacant & Seasonal	(1,431)	(1,481)	(1,648)	(1,820)	(1,991)	(2,170)
Total Households	9,595	10,713	12,199	13,652	15,106	16,483
Road Mileage:						
Gravel	575	567	557	548	541	535
Asphalt and Oil Mat	750	763	781	796	810	823
Concrete	4	5	5	6	6	7
Total Road Mileage	1,329	1,334	1,343	1,350	1,357	1,365
Road Miles Per 100 Households	13.85	12.46	11.01	9.89	8.99	8.28

Washington County

The population of Washington County quadrupled between 1960 and 1995, making it the fastest growing county in Oregon. This strong performance will continue, although, following the pattern of the whole state, the rate of increase will slow over time.

From 2001 to 2050, the number of households in Washington County will rise 160,884. A high percentage of these will be young wage-earning families. This will result in above average incomes and an extensive amount of construction of offices, stores, and manufacturers.

Residents over 64 years of age will make up 10% of the county's population in the year 2000. While this will climb to 18% by 2050, it will still be far less than the rest of Oregon. The county is attractive to businesses but is less affordable and more congested than other parts of the state. Many retirees, therefore, will prefer to live elsewhere.

The housing stock will grow by 171,978 units during the forecast period. Virtually all of this increase will come from higher levels of occupied and vacant housing. Seasonal housing is insignificant. The percentage of the population living in cities, towns, and suburbs will reach 98% in 2050. In 1990, it was 94%. With this high level of urbanization, half of all the new housing put in place will be multi-family. Seven out of eight single-family homes will be site built.

Washington County ranks next to last in road mileage per person. The county will add 674 miles during the forecast period. Roads will account for 16% of anticipated aggregate consumption. Logging and other forestry roads will use about 50,000 ton a year, or 1% of the total.

Washington County will use 323.5 million tons of aggregate from 2001 to 2050. About 25.9 million will come from recycling. Virgin aggregate consumption will total 297.6 million tons, or 5,951,334 tons per year. It will rise at an annual rate of 0.63%.

Washington County produces very little sand and gravel because it is deficient in good deposits. It imports sand and gravel from Columbia County and other counties, while shipping out some crushed rock.

Table 3.69

Forecast of Annual Average Aggregate Consumption for Washington County (in tons)

	2001-2010	2011-2020	2021-2030	2031-2040	2041-2050
End Use:					
Residential Construction	1,161,022	1,226,364	1,280,699	1,373,071	1,431,179
Nonresidential	1,717,693	2,006,410	2,308,392	2,595,959	2,955,933
Roads	981,817	1,003,737	1,024,851	1,065,092	1,095,993
Other Infrastructure	1,046,624	1,194,056	1,334,672	1,479,436	1,618,946
Miscellaneous Uses	394,172	444,205	491,853	536,409	582,145
Total Consumption	5,301,327	5,874,772	6,440,467	7,049,967	7,684,197
Less Recycled Materials	(323,496)	(410,140)	(506,061)	(615,781)	(738,582)
Virgin Aggregate Use	4,977,831	5,464,632	5,934,406	6,434,186	6,945,615
Tons Per Capita	10.9	10.2	9.7	9.3	9.0

Table 3.70

Forecast of Population, Housing, and Road Mileage Data for Washington County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	109,797	122,202	138,215	157,034	173,429	192,869
18 to 64 Years Old	267,405	317,441	354,604	380,830	424,895	473,672
Over 64 Years Old	39,687	51,904	77,437	112,196	130,800	142,754
Total Population	416,889	491,547	570,256	650,060	729,124	809,295
10-Year % Growth	33.2%	17.9%	16.0%	14.0%	12.2%	11.0%
Personal Income (Mn. 1987$)	$7,452	$9,317	$11,514	$14,045	$16,935	$20,301
10-Year % Growth	36.0%	25.0%	23.6%	22.0%	20.6%	19.9%
Housing Stock (Units):						
SF Site-Built Homes	105,863	122,503	138,581	153,948	169,502	184,374
SF Manufactured Homes	8,535	11,417	13,761	15,602	17,116	18,245
Multi-family Housing Units	52,715	68,247	84,286	100,498	117,763	135,036
Other Housing	1,553	1,853	2,149	2,432	2,718	2,990
Less Vacant & Seasonal	(8,952)	(11,928)	(14,079)	(16,064)	(18,088)	(20,046)
Total Households	159,715	192,092	224,699	256,417	289,012	320,599
Road Mileage:						
Gravel	509	512	517	525	534	545
Asphalt and Oil Mat	1,822	1,943	2,063	2,182	2,305	2,430
Concrete	37	43	49	55	61	66
Total Road Mileage	2,367	2,498	2,629	2,762	2,900	3,041
Road Miles Per 100 Households	1.48	1.30	1.17	1.08	1.00	0.95

Wheeler County

Wheeler County's population fell sharply from 1960 to 1983. It has since stabilized. We expect very little change in the future. The county's geographic isolation makes it difficult for it to create the employment opportunities necessary for growth.

Wheeler County will attract retirees, but lose people of working age. From 2001 to 2050, the number of residents over 64 will rise by 176. Partly offsetting this will be a decline of 132 people below 65 years of age. The number of households will go up by 41.

The number of housing units in the county will rise by 98 during the forecast period. More than half of these will be seasonal and vacation homes. Only 48% of the residents will be living in towns in 2050. That is the lowest percentage of any county in Oregon. Because so much of its population lives in remote areas, manufactured housing is popular in Wheeler County and will account for 74% of the new single-family units put in place.

The county has the fewest miles of improved roads in Oregon. However, because it also has the smallest population, there are few markets for aggregate other than roads. Consequently, roads take up a large 69% share of Wheeler County's total aggregate consumption. Logging and related roads will make up 5% of the total. Farms and ranches are the second biggest end use.

Total aggregate consumption will be 7.2 million tons. Virgin aggregate consumption will be 6.8 million tons between the years 2001 and 2050. That equals an annual level of 136,845 tons and is the lowest of any county in the state. Consumption of virgin aggregate will fall at a rate of 0.05% per year.

Table 3.71

Forecast of Annual Average Aggregate Consumption for Wheeler County (in tons)

	2001-2010	2011-2020	2021-2030	2031-2040	2041-2050
End Use:					
Residential Construction	1,558	3,225	2,927	2,993	3,079
Nonresidential	30,653	30,432	30,305	30,241	30,292
Roads	98,643	101,040	99,668	99,596	99,531
Other Infrastructure	9,751	9,797	9,772	9,793	9,836
Miscellaneous Uses	977	984	987	990	992
Total Consumption	141,581	145,478	143,658	143,613	143,730
Less Recycled Materials	(5,179)	(6,087)	(6,767)	(7,521)	(8,284)
Virgin Aggregate Use	136,402	139,391	136,891	136,093	135,446
Tons Per Capita	91.1	93.6	90.7	89.0	87.4

Table 3.72

Forecast of Population, Housing, and Road Mileage Data for Wheeler County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	318	299	289	289	289	299
18 to 64 Years Old	822	759	739	699	699	709
Over 64 Years Old	374	420	470	530	550	550
Total Population	1,514	1,478	1,498	1,518	1,538	1,558
10-Year % Growth	8.1%	-2.4%	1.4%	1.3%	1.3%	1.3%
Personal Income (Mn. 1987$)	$20	$20	$21	$23	$25	$28
10-Year % Growth	8.8%	2.3%	7.2%	8.2%	9.2%	10.2%
Housing Stock (Units):						
SF Site-Built Homes	546	519	507	495	487	484
SF Manufactured Homes	166	181	246	291	328	359
Multi-family Housing Units	10	10	11	11	12	12
Other Housing	75	67	61	54	47	40
Less Vacant & Seasonal	(170)	(158)	(187)	(203)	(216)	(227)
Total Households	627	618	638	648	658	668
Road Mileage:						
Gravel	229	229	229	229	229	228
Asphalt and Oil Mat	243	243	243	243	243	244
Concrete	0	0	0	0	0	0
Total Road Mileage	471	472	472	472	472	472
Road Miles Per 100 Households	75.19	76.30	73.94	72.82	71.74	70.69

Yamhill County

Yamhill County's population grew at a 2.44% rate from 1960 to 1995. It will rise at a 1.39% rate in the forecast period. The number of households in Yamhill County will rise by 30,082.

The county benefits from its proximity to the Portland metropolitan area. Its transportation infrastructure, however, is not as favorable as some of its neighboring counties, and this is a limiting factor for development. The county ranked only 17th in per capita income in 1990, compared to the one, two, and three rankings of Multnomah, Clackamas, and Washington Counties, respectively.

Vacation and seasonal housing are minor factors in Yamhill County. The housing stock, therefore, will increase mostly to accommodate new families and the normal level of vacancies. We expect that the housing stock will rise by 32,179 units. Multi-family housing will constitute 27% of the new units put in place. Site-built single-family homes will make up 58% of the total.

In 1990, 74% of the county's residents lived in towns and suburbs. By 2050, this will rise to 84%. That is still much less than one would expect for such a densely populated county. Yamhill County farmland, however, is very productive and can support many farms.

The county will add 139 miles of new roads. Logging and forest-related roads will consume 4% of the county's aggregate. Three-fourths of this will be used by private logging companies. Another 4% will be used in agriculture. Gravel is widely used on private farm roads and for container nurseries in Yamhill County.

Total aggregate consumption will be 70.1 million tons from 2001 to 2050. Recycling will account for 4.9 million tons. Virgin aggregate consumption will equal 65.2 million tons, or 1,304,805 tons a year. The annual growth rate for virgin aggregate consumption will be 0.56%.

Table 3.73

Forecast of Annual Average Aggregate Consumption for Yamhill County (in tons)

	2001-2010	2011-2020	2021-2030	2031-2040	2041-2050
End Use:					
Residential Construction	230,282	255,515	267,083	284,681	295,420
Nonresidential	297,141	346,671	400,474	451,766	518,134
Roads	409,528	410,766	402,576	400,280	395,234
Other Infrastructure	174,611	201,974	227,689	254,248	280,337
Miscellaneous Uses	81,213	92,156	102,399	111,976	121,806
Total Consumption	1,192,776	1,307,082	1,400,222	1,502,951	1,610,931
Less Recycled Materials	(60,837)	(78,159)	(95,999)	(116,228)	(138,712)
Virgin Aggregate Use	1,131,938	1,228,923	1,304,223	1,386,724	1,472,219
Tons Per Capita	12.2	11.3	10.3	9.7	9.2

Table 3.74

Forecast of Population, Housing, and Road Mileage Data for Yamhill County

	2000	2010	2020	2030	2040	2050
Population:						
0 to 17 Years Old	23,320	27,212	30,966	35,223	39,092	43,639
18 to 64 Years Old	50,808	60,941	68,538	73,925	82,840	92,685
Over 64 Years Old	9,995	11,772	17,286	24,744	28,903	31,691
Total Population	84,123	99,925	116,790	133,892	150,835	168,015
10-Year % Growth	28.2%	18.8%	16.9%	14.6%	12.7%	11.4%
Personal Income (Mn. 1987$)	$1,187	$1,506	$1,884	$2,318	$2,811	$3,380
10-Year % Growth	33.8%	26.8%	25.1%	23.1%	21.3%	20.2%
Housing Stock (Units):						
SF Site-Built Homes	20,525	24,089	28,039	32,009	36,143	40,229
SF Manufactured Homes	4,224	5,376	6,415	7,256	7,961	8,502
Multi-family Housing Units	5,033	6,391	7,933	9,516	11,199	12,889
Other Housing	657	745	832	901	959	998
Less Vacant & Seasonal	(1,669)	(2,197)	(2,611)	(2,998)	(3,389)	(3,766)
Total Households	28,770	34,405	40,608	46,685	52,873	58,852
Road Mileage:						
Gravel	558	548	541	535	532	530
Asphalt and Oil Mat	795	829	862	893	924	954
Concrete	9	11	12	14	16	17
Total Road Mileage	1,362	1,387	1,415	1,443	1,472	1,501
Road Miles Per 100 Households	4.73	4.03	3.48	3.09	2.78	2.55